CS7B

MULTI-AMP®
BIDDLE™
MEGGER®

Biddle
CS-7B
Ref # 12755

Electrical Test Equipment
Measuring Instruments
Testing and
Training Services

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AVO INTERNATIONAL

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INSTRUCTION MANUAL

For

CS-7B

SERIAL NO._____

It is essential that this instruction book be read thoroughly before putting the equipment in service.

Part No. 12435
Rev. 1 8/14/91

IMPORTANT

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AVO INTERNATIONAL

MULTI-AMP® PORTABLE PHASE-SHIFTER UNIT
Model CS-7B

General Description

The Multi-Amp® Model CS-7B incorporates a solid-state, digital phase angle meter and control circuitry which simplifies testing of the more complex protective relays. The unit may be used in conjunction with various test apparatus, such as load boxes or resistance loads, and is ideally suited as a companion unit to any of Multi-Amp's "basic" relay test sets, such as Models SR-76A or SR-77.

Applications

Model CS-7B is designed to test and calibrate single-phase and three-phase electromechanical and solid-state protective relays which require control of the phase angle relationship. Typical types of relays with which Model CS-7B is used are directional overcurrent, reverse power, synchronizing, loss of field, out-of-step tripping, out-of-step blocking and distance relays (mho, ohm and reactance).

Features

Among the many standard facilities incorporated in Model CS-7B which reduce setup time, simplify test procedures and increase accuracy are:

- Numerous single- and three-phase outputs.
- A digital phase angle meter which precisely measures the phase angle relationship between the outputs of the unit and an external current or potential.
- A digital phase angle meter that can be used independently to measure the phase angle between two external currents, two external potentials or an external current and an external potential.
- A phase angle meter that does **not** require sinusoidal inputs to maintain rated accuracy (input current and/or potentials can contain up to 30% harmonic distortion without degrading accuracy).
- A special circuit that supplies the potentials required for testing three-phase distance relays.
- A three-phase, four-wire potential for testing three-phase ground distance relays.
- The capability to simultaneously supply one single-phase potential, with an adjustable phase angle, and another single-phase potential, which either leads or lags the first by a fixed 90°, for testing single-phase, ground-polarized distance or directional relays.
- Capability for testing three-phase undervoltage or overvoltage relays. Includes provisions to initiate an external timer.
- Overload and short-circuit protection on input and output circuits.

Specifications

Input Voltage (switch-selected). Specify one:

120/208/240 V, 3Φ, **OR** 230/380/415 V, 3Φ

Frequency (Specify One)

58 to 62 Hz on units with 60 Hz rating **OR**

48 to 52 Hz on units with 50 Hz rating

Outputs

- 0 to 120 V L-L, 3Φ, rotatable through 360° (200 VA)
- 0 to 120 V, 1Φ, rotatable through 360° (65 VA)
- 0 to 120 V, 1Φ, lagging or leading output #2 by 90° (25 VA)
- Complete 3Φ potential source for testing Westinghouse KD series relays per IL.41-491.
- 0 to 120 V L-L, 3Φ, 200 VA variable potential source
- 0 to 120 V phase to neutral, 3Φ, 4-wire, rotatable through 360° (200 VA)

Adjustment

Phase angle is adjustable through 360° by means of a six-position, sector-selector switch and a vernier, fine control.

Phase Angle Meter

A Multi-Amp solid-state, digital phase angle meter designed specifically for power system applications is incorporated to measure the phase angle between the various outputs of the unit and an external current or potential. Additionally, it may be used independently to measure the phase angle between two external currents, two external potentials or an external current and an external potential. The four-digit, solid-state display appears as continuous, solid, unbroken numerals with no gaps between the segments to impair readability.

Display

0.0° to 359.9°. Non-flickering, 0.55-in. (14 mm) flat, planar numerals using high intensity gas-discharge technology.

Accuracy

±1.0° over entire rated input ranges of current, potential and frequency. Additionally, specified accuracy is maintained even if inputs contain up to 30% harmonic distortion.

Inputs (two identical input circuits)

Current: 0.5 to 10 A
Potential: 10 to 250 V

Indication is automatically given when the current and/or potential inputs are above or below their rated range, thus eliminating the need for instrumentation to monitor inputs. One input circuit of the phase angle meter is automatically connected to the outputs of the unit. However, if external inputs are desired for both input circuits, this is accomplished by a single toggle switch.

Protection

Overload and short-circuit protection is provided on input and output circuits.

Enclosure

The unit is housed in a heavy-duty Formica case with a removable hinged cover and carrying handles on both the top and sides.

Model CS-7B with control unit of Model SR-76A testing a directional overcurrent relay

Dimensions

16.5 H x 14 W x 11 D in.
(419 H x 356 W x 279 D mm)

Weight

120/208/240 V unit: 64 lbs. (29.0 kg)

230/380/415 V unit: 69 lbs. (31.3 kg)

Ordering Information

Item	Part No.
Model CS-7B	
Specify desired input:	
115 V, 60 Hz	CS-7B-115/60
415 V, 50 Hz	CS-7B-415/50

Standard Accessories

Item (Qty.)	Part No.
Test leads (3 pair)	282
Fuses:	
3 A, 250 V, MDA (5)	951
3/4 A, 250 V, MDA (10)	2679
1/2 A, 250 V, MDL (5)	982
Instruction Manual	3413

Optional Accessories

Item (Qty.)	Part No.
Reuseable shipping container	3111

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DESCRIPTION OF CONTROLS

The following is a description of the various controls on the panel of the test set. The Test Procedures section of this manual gives detailed instructions for the set-up of the controls to obtain the various outputs available from the test set.

INPUT VOLTAGE SELECTOR: The INPUT VOLTAGE SELECTOR Switch should be set to the appropriate value for the voltage (phase-to-phase) being applied to the INPUT POWER binding posts.

INPUT POWER binding posts A, B, C, & N and fuses: Binding posts for connection of the input power to the test set. Fuses are provided for overload and short circuit protection.

NOTE: It is always necessary to connect the test set to a suitable 3Ø source of supply even if only a single phase output is desired. The only exception to this requirement is if the phase angle meter is to be used for external applications and no output is required from the test set. See page 10 for details.

ON/OFF Switch: Used to energize the input of the test set.

POWER ON light: Indicates whenever the input to the test set is energized.

BRUSH #1, #2 & #3: Variable autotransformers which are used to adjust the magnitude of the potential of the various outputs.

FUSES #1, #2 & #3: Fuses which protect BRUSHES #1, #2 & #3.

Binding Posts I, II, III, IV: These binding posts are provided for making connections to the output of the test set.

TO EXT. V.M. binding posts: These binding posts are provided for use in measuring the outputs of the test set in conjunction with an external voltmeter.

TO EXT. INITIATE binding posts: These binding posts are used to connect an external timer for use in conducting timing tests on 3Ø voltage relays.

PHASE SHIFTER ADJUSTMENT FINE and COARSE controls:	Adjustment of the phase relationship between either an external reference current or potential and the various potential outputs of the test set is controlled by the COARSE and FINE control knobs. The COARSE control knob provides six 60° segments of adjustment, while the FINE control knob provides smooth adjustment with overlap within each 60° segment. By alternately adjusting the FINE and COARSE control knobs, the phase angle can be rotated a full 360° in either direction (clockwise or counterclockwise). The FINE control knob is also used in conjunction with the BALANCED 3Ø ON position of the MODE Switch to provide ganged control of a balanced three phase potential output.
FINE CONTROL fuses:	Protect the PHASE SHIFTER ADJUSTMENT.
Phase Angle Meter:	A solid state digital phase angle meter indicates the phase angle which PAM INPUT 1 lags PAM INPUT 2. Refer to page 6 for a complete discussion on use of the phase angle meter.
PAM fuse:	Protects the phase angle meter display and logic power supply.
PAM INPUT 1 (EXT. ONLY):	Binding posts for connecting an external potential or current to one input circuit of the phase angle meter.
PAM INPUT 2 binding posts and INTERNAL/EXTERNAL Switch:	The other input circuit of the phase angle meter can be energized either internally from the various outputs of the test set by switching the INTERNAL/EXTERNAL Switch to the INTERNAL position, or energized externally by switching the INTERNAL/EXTERNAL Switch to the EXTERNAL position and applying the input to the appropriate binding posts.
MODE Switch:	The MODE Switch is used in conjunction with the OUTPUT FUNCTION Switch to select the output to be obtained from the test set. The following is a discussion of each position.

NORM.: The NORM.(normal) position is used in conjunction with the 1Ø, 3Ø (delta) and 3Ø Y (wye) positions of the OUTPUT FUNCTION Switch to obtain the phase shiftable outputs.

Ø - Ø FAULT: The Ø - Ø FAULT positions are used in conjunction with the Ø - Ø position of the OUTPUT FUNCTION Switch for performing a phase-to-phase test on the Ø - Ø element of three-phase directional distance relays such as the Westinghouse KD series. The I-II, II-III and III-I positions indicate which phase-to-phase voltage is faulted.

BALANCED 3Ø: When the MODE Switch is in the BALANCED 3Ø ON position, a continuously adjustable, balanced three-phase potential is available at the I, II, III output binding posts. Ganged control from 0 to maximum is provided by the BALANCED 3Ø control (same as FINE control of PHASE SHIFTED ADJUSTMENT) which is located directly below the MODE Switch.

The OFF position is used in conjunction with the TO EXT. INITIATE binding posts for conducting timing tests on three-phase voltage relays. When the MODE Switch is switched from the BALANCED 3Ø ON position to the 3Ø OFF position, the output is de-energized and a contact which is wired across the TO EXT. INITIATE binding posts is closed to initiate an external timer.

OUTPUT FUNCTION Switch: The OUTPUT FUNCTION Switch is used in conjunction with the MODE Switch to select the output to be obtained from the test set. BRUSHES #1, #2, and #3 are provided to control the magnitude of the outputs; and the EXT. VOLTMETER Switch is used in conjunction with the TO EXT. V.M. binding posts to measure the outputs with an external voltmeter, and to determine which potential is applied to the PAM INPUT 2 circuit of the phase angle meter.

The following positions of the OUTPUT FUNCTION Switch are used in conjunction with the NORM. (normal) position of the MODE Switch.

1Ø: A single-phase, phase-shiftable potential is available at the I-II binding posts and is adjustable in magnitude by BRUSH #1.

If required, a second, independent single-phase potential is available at the III-IV binding posts and is adjustable in magnitude by BRUSH #2. The I-II and III-IV outputs are separated by a fixed phase angle of 90°.

3Ø Y (wye): A three-phase, 3-wire delta, phase-shiftable potential is available at the I, II, III binding posts. BRUSH #1, #2, and #3 adjust the I-IV, II-IV, and III-IV phase-to-neutral potentials.

3Ø (delta): A three-phase, 3-wire delta, phase-shiftable potential is available at the I, II, and III binding posts. BRUSH #1, controls the magnitude of the I-II potential and BRUSH #2 controls II-III.

The following position of the OUTPUT FUNCTION Switch is used in conjunction with the Ø-Ø FAULT I-II, II-III and III-I positions of the MODE Switch:

Ø-Ø: The Ø-Ø position is provided for use in conducting tests on the phase-to-phase element of three-phase distance relays such as the Westinghouse KD series. A 3Ø phase -shiftable potential is available at the I, II, and III output binding posts; however, the magnitude of only one phase-to-phase voltage is variable and adjustable as determined by the Ø-Ø FAULT position of the MODE Switch. Adjustment of the phase-to-phase potential is provided by first collapsing the potential vectors by positioning BRUSH #1 and #2 at the midpoint of the variable autotransformers (white line on the panel of the test set), then rotating BRUSH #1 in a clockwise direction to obtain $^1/_2$ of the desired fault voltage and rotating BRUSH #2 counterclockwise until the total fault voltage is obtained.

EXT. VOLTMETER Switch:

Facilities are incorporated to easily measure the output potential of the test set with an external voltmeter. When a voltmeter is connected to the binding posts labeled TO EXT. V.M., all combinations of phase-to-phase and phase-to-neutral voltages can be measured by switching the EXT. VOLTMETER Switch to the appropriate position.

The EXT. VOLTMETER Switch is also used in conjunction with the OUTPUT FUNCTION Switch for selecting the INTERNAL voltage being supplied to PAM INPUT 2 of the phase angle meter. See page 7 for further details.

DIGITAL PHASE ANGLE METER

A solid state digital phase angle meter is incorporated to measure the phase relationship between the various outputs of the test set and either an external reference current or an external reference potential. In addition, the phase angle meter can be used independently to measure the phase relationship between two external AC currents, two external AC potentials or an external AC current and external AC potential. Inputs to the phase angle meter are designated PAM INPUT 1 and PAM INPUT 2.

If a suitable power source is connected to the input of the test set, and the POWER ON Switch is switched to the ON position, the phase angle meter will display a phase angle only if **both** INPUT 1 and INPUT 2 are energized **simultaneously** with either a current or a potential equal to or greater than the minimum input level of a 0.5 ampere or 10 volts. If either of the inputs is below these levels, the phase angle meter will indicate all eights (888.8). Both inputs must be within the limits of 0.5 to 10 amperes or 10-250 volts for the phase angle meter to display within its accuracy specification. If the magnitude of one or both of the inputs is above the input level ratings, the display will begin to blink (flash on and off) indicating that the magnitude of the input is excessive and that the error in measurement is greater than the accuracy specification. When the display indicates all eights (888.8), the display will not necessarily be fully illuminated; however, the display will be fully illuminated when a finite phase angle is displayed.

PAM INPUT 1 (EXT. ONLY):

INPUT 1 is used as the reference input to the phase angle meter and the input can either be an external current or an external potential. Connections for INPUT 1 are made at the binding posts marked PAM INPUT 1 (EXT. ONLY). When a current is used for INPUT 1, it should be connected in series with the load by connecting one lead to the binding post labeled $\pm$ and the other lead to the binding post marked 0.5-10A. When a potential is used for INPUT 1, it should be connected in parallel with the load by connecting one lead to the $\pm$ binding post and the other lead to the 10-250V binding post.

PAM INPUT 2:

PAM INPUT 2 is normally energized internally from the various outputs of the test set; however, facilities are incorporated to energize INPUT 2 with an external current or voltage. The position of the INTERNAL/EXTERNAL Switch determines whether INPUT 2 is energized within the test set or whether it is energized externally. When INPUT 2 is to be energized from either an external current or potential, the INTERNAL/EXTERNAL Switch should be in the EXTERNAL position and the external current should be applied to the $\pm$ and 0.5-10A binding posts, or the external potential should be applied to the $\pm$ and 10-250V binding posts.

PAM INPUT 2 Energized Internally

The INTERNAL inputs which are applied to PAM INPUT 2 are determined by the EXT. VOLTMETER Switch and the output function Switch as follows.

When the OUTPUT FUNCTION Switch is in the 1Ø position, the EXT. VOLTMETER Switch is used to determine whether the I-II or III-IV potential is applied to PAM INPUT 2. Input to the phase angle meter is made at the output binding posts, therefore, BRUSH #1 and/or BRUSH #2 must be rotated clockwise sufficiently to provide potential input so the phase angle meter will indicate a finite phase angle.

When the OUTPUT FUNCTION Switch is in the 3ØY (wye) position, the EXT. VOLTMETER Switch is used to determine which phase-to-neutral or phase-to-phase voltage is applied to PAM INPUT 2. Inputs to the phase angle meter is made at the output binding posts so BRUSH #1, #2, and #3 must be rotated clockwise sufficiently to provide a potential input so the phase angle meter will indicate a finite phase angle.

When the OUTPUT FUNCTION Switch is in either the 3Ø (delta) or the Ø-Ø (phase-to-phase) positions, the potential which is applied to PAM INPUT 2 is the phase-to-phase voltage I-II, and is independent of the position of the EXT. VOLTMETER Switch. This connection is made to the primary of BRUSH #1, so that the phase angle meter indicates a finite phase angle regardless of the position of BRUSH #1.

Independent, external use of Phase Angle Meter:

In the event that it is desirable to use the phase angle meter independently with external inputs (no output required), the test set may be connected to a suitable source of single phase power to illuminate the display of the phase angle meter. In this case, a single phase voltage equal to the lowest value indicated on the INPUT VOLTAGE SELECTOR Switch may be connected to INPUT POWER binding posts A and C. The INPUT POWER SELECTOR Switch should be set at the lowest input voltage position, and the PAM INPUT 2 INTERNAL/EXTERNAL Switch should be put in the EXTERNAL position.

The phase angle meter can then be illuminated by switching the POWER ON/OFF Switch to ON. Appropriate inputs can then be connected simultaneously to PAM INPUT 1 and PAM INPUT 2 and their phase relationship will be indicated on the phase angle meter.

USE OF MODEL CS-7B WITH MODELS SR-51A, SR-77 OR SR-76A

Model CS-7B is designed to be used in conjunction with a load box or resistance load, or it is ideally suited as a companion unit to any of Multi-Amp basic relay test sets such as Models SR-51A, SR-77 or SR-76A.

When using Model CS-7B in conjunction with Models SR-51A, SR-77 or SR-76A, the voltmeter in these test sets would normally be used to measure the potential outputs of Model CS-7B. Additionally, the SR-51A, SR-77 or SR-76A would be used to provide the reference input current or potential which is connected to PAM INPUT 1 on Model CS-7B.

To use the voltmeter on these units, connect the TO EXT. V.M. binding posts on Model CS-7B to the EXT. V.M. binding posts on Model SR-51A, SR-77 or SR-76A. Set the VOLTMETER SELECTOR Switch on these units to the EXT.A.C. position and the VOLTMETER RANGE Switch to the appropriate position.

When using Model SR-51A, SR-77 or SR-76A as the reference test current, the current output from these units can be connected directly in series with the PAM INPUT 1 **provided** the test current is within the limits of 0.5 To 10 amperes. For currents greater than 10 amperes, the PAM jack on the SR-51A, SR-77 or SR-76A should be used. The PAM jack is connected to the 5 ampere secondary of the current transformer in series with the ammeter in the test set. Therefore, as long as the ammeter does not exceed full scale value, the phase angle meter input current will not exceed 5 amperes, regardless of the output test current. When the PAM jack is used, the Black lead on the telephone-type plug which is supplied with Models SR-51A, SR-77 or SR-76A is the instantaneous polarity ($\pm$) lead.

The timer on Models SR-51A, SR-77 and SR-76A may be used in conjunction with the BALANCED 3Ø ON/OFF positions of the MODE Switch on Model CS-7B for conducting timing tests on 3Ø voltage relays. See pages 22 through 23 for details.

USE OF THE PHASE ANGLE METER FOR EXTERNAL APPLICATIONS

Connect the test set to either a suitable 3Ø power supply or if desired, the unit may be connected to a single phase source of supply corresponding to the lowest value indicated on the INPUT VOLTAGE SELECTOR Switch. When using a single phase source, power supply connections must be made to input binding posts A and C.

INPUT VOLTAGE SELECTOR	To appropriate position if input is a 3Ø source, or to the lowest input voltage is a 1Ø source is used.
PAM INPUT 2 INTERNAL/EXTERNAL Switch	EXTERNAL position.
POWER ON/OFF Switch	ON. POWER ON light and the phase angle meter display should illuminate.

Connect either a current or a potential to INPUT 1 and INPUT 2. Two currents, two potentials or a current and a potential can be used for inputs. For the phase angle meter to indicate the phase relationship within $\pm 1°$, the inputs must be within 0.5-10 ampere or 10-250 volts. Current input should be connected in series with the load by connecting one lead to the $\pm$ binding post and the other lead to the 0.5-10A binding post. Potential input should be connected in parallel with the load by connecting one lead to the $\pm$ binding post and the other lead to the 10-250V binding post. If the phase angle meter reads all eights (888.8) with inputs connected, one or both inputs are below the minimum level. If the display blinks, one or both inputs are excessive. For complete description of the phase angle meter refer to page number 6 of the manual.

SINGLE-PHASE, PHASE-SHIFTABLE OUTPUT

TYPICAL APPLICATIONS:	Testing single-phase directional or distance relays, synchronizing relays, loss of excitation, loss of field, out-of-step blocking, out-of-step tripping, power, etc.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay's characteristics, types of tests and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	To appropriate position for power supply being used.
INPUT POWER binding posts	Connect unit to a suitable three-phase power supply.
MODE Switch	NORMAL
OUTPUT FUNCTION Switch	1Ø
EXT.VOLTMETER Switch	I-II
BRUSH #1, #2, #3	Full counterclockwise rotation
PAM INPUT 2 INTERNAL/EXTERNAL Switch	INTERNAL
TO EXT. V.M. binding posts	Connect external voltmeter with suitable ranges.
I-II output binding posts	Connect potentials coils of relay.
PAM INPUT 1	Connect external reference current or potential.
POWER ON/OFF Switch	ON. The POWER ON light and the phase angle meter display should illuminate.
BRUSH #1	Rotate BRUSH #1 clockwise until the phase angle meter displays a finite phase angle.
PHASE SHIFTER ADJUSTMENT:	
COARSE	Position COARSE control to give the desired 60° segment.
FINE	Adjust FINE control to set the desired phase angle.
BRUSH #1	Adjust BRUSH #1 to obtain the desired test voltage.

TWO INDEPENDENT, SINGLE-PHASE, PHASE-SHIFTABLE OUTPUTS, ONE FIXED 90° AWAY FROM THE OTHER

TYPICAL APPLICATION:	Testing of ground polarized directional or distance relays such as the General Electric Type GCXG.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay characteristics, type of tests, and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	To appropriate position for power supply being used.
INPUT POWER binding posts	Connect unit to a suitable three-phase power supply.
MODE Switch	NORMAL
OUTPUT FUNCTION Switch	1Ø
EXT.VOLTMETER Switch	I-II
BRUSH #1, #2, #3	Full counterclockwise rotation
PAM INPUT 2 INTERNAL/EXTERNAL Switch	INTERNAL
TO EXT. V.M. binding posts	Connect EXTERNAL VOLTMETER with suitable ranges.
I-II OUTPUT binding posts	Connect main potential coil of relay. Binding post I is polarity terminal.
III-IV OUTPUT binding posts	Connect polarizing potential coil of relay. The III-IV voltage will **lead** the I-II voltage when binding post III is connected to $\pm$ potential terminal of the relay and will **lag** when binding post IV is used as polarity.
PAM INPUT 1	Connect external reference current.
POWER ON/OFF Switch	ON. The POWER ON light and the phase angle meter display should illuminate.
BRUSH #1	Rotate BRUSH #1 clockwise until the phase angle meter indicates a finite phase angle.

PHASE SHIFTER ADJUSTMENT:

COARSE	Position COARSE control to give the desired 60° segment.
FINE	Adjust FINE control to give the desired phase angle relationship for output I-II.
BRUSH #1	Adjust BRUSH #1 to obtain the desired test voltage I-II.
EXT. VOLTMETER Switch	Adjust EXT.VOLTMETER Switch to the III-IV position.
BRUSH #2	Adjust BRUSH #2 to obtain the desired test voltage III-IV.

THREE-PHASE DELTA
PHASE-SHIFTABLE OUTPUT

TYPICAL APPLICATION:	Testing 3Ø element of three-phase distance relays such as the Westinghouse KD series.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay's characteristics, types of tests, and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	Switch to appropriate position for power supply being used.
INPUT POWER binding posts	Connect the unit to a suitable three-phase power supply. Observe proper phase sequence rotation.
MODE Switch	NORMAL
OUTPUT FUNCTION Switch	3Ø Delta
EXT. VOLTMETER Switch	I-II
BRUSH, #1, #2, #3	Full counterclockwise rotation
PAM INPUT 2 INTERNAL.EXTERNAL Switch	INTERNAL
TO EXT.V.M. binding posts	Connect external voltmeter with suitable ranges
I, II, III, OUTPUT binding posts	Connect potential coils of relay
PAM INPUT 1	Connect external reference current or potential
POWER ON Switch	ON. The POWER ON light and the display of the phase angle meter should illuminate.
PHASE SHIFTER ADJUSTMENT:	
COARSE	Position COARSE adjustment to the desired 60° segment.
FINE	Adjust FINE control to set the desired phase angle. NOTE: When the FUNCTION Switch is positioned in the 3Ø delta position, INPUT 2 of the phase angle meter is connected to the primary of BRUSH #1 which is used to control the voltage from binding posts I-II. This connection is the same as shown in the Westinghouse instruction booklet for the KD series of relays.

BRUSH #1	Adjust BRUSH #1 to set the phase-to-phase voltage at the I-II binding posts to the desired value.
EXT.VOLTMETER Switch	Switch to the II-III position.
BRUSH #2	Adjust BRUSH #2 to set the phase-to-phase voltage at the II-III binding posts.
EXT.VOLTMETER Switch	Switch to III-I, II-III and I-II positions to check balance of output. When the magnitudes of these voltage outputs are equal, the phase relationship between them is 120°.

THREE-PHASE, 4-WIRE (WYE)
PHASE-SHIFTABLE OUTPUT

Typical Applications:	Testing 3Ø relays such as the English Electric YTG-31, G.E. Type SLYG or Westinghouse Type SDG.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay's characteristics, types of tests, and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	Switch to appropriate position for power supply being used.
INPUT POWER binding posts	Connect the unit to a suitable three-phase power supply. Observe proper phase sequence rotation.
MODE Switch	NORMAL
OUTPUT FUNCTION Switch	3Ø Y (Wye)
EXT. VOLTMETER Switch	I-IV
BRUSH, #1, #2, #3	Full counterclockwise rotation
I, II, III, IV OUTPUT binding posts	Connect potential coils of relay
PAM INPUT 2 INTERNAL.EXTERNAL Switch	INTERNAL
TO EXT.V.M. binding posts	Connect external voltmeter with suitable ranges
PAM INPUT 1	Connect external reference current or potential
POWER ON Switch	ON. The POWER ON light and the display of the phase angle meter should illuminate.
BRUSH #1	Rotate BRUSH #1 clockwise a sufficient amount to cause the phase angle meter to display a finite phase angle.
PHASE SHIFTER ADJUSTMENT:	
COARSE	Position COARSE adjustment to the desired 60° segment.
FINE	Adjust FINE control to set the desired phase angle relationship between the external reference current or potential and the phase-to-neutral voltage I-IV.

BRUSH #1	Adjust BRUSH #1 to set the desired voltage for the phase-to-neutral I-IV.
EXT.VOLTMETER Switch	Change to II-IV.
BRUSH #2	Adjust BRUSH #2 to set the desired voltage for the phase-to-neutral voltage II-IV.
EXT.VOLTMETER Switch	Change to III-IV.
BRUSH #3	Adjust BRUSH #3 to set the desired voltage for the phase-to-neutral voltage III-IV.
EXT.VOLTMETER Switch	The EXT.VOLTMETER Switch can be adjusted to read all combinations of Ø-Ø and Ø-N voltages. In addition, the phase relationship between all combinations of Ø-Ø and Ø-N voltages and the external reference can be read on the phase angle meter.

PHASE-TO-PHASE FAULT TEST ON THREE-PHASE DISTANCE RELAYS

Typical Application:	Testing Ø-Ø element of three-phase distance relays such as the Westinghouse KD series.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay's characteristics, types of tests, and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	Switch to appropriate position for power supply being used.
INPUT POWER binding posts	Connect the unit to a suitable three-phase power supply. Observe proper phase sequence rotation.
MODE Switch	I-II
OUTPUT FUNCTION Switch	Ø-Ø
EXT.VOLTMETER Switch	I-II
BRUSH #1 and #2	Position at the physical midpoint of the variable autotransformer (white line on panel of test set).
BRUSH #3	Full counterclockwise rotation
I, II, III, IV OUTPUT binding posts	Connect potential coils of relay
PAM INPUT 2 INTERNAL.EXTERNAL Switch	INTERNAL
TO EXT.V.M. binding posts	Connect external voltmeter with suitable ranges
PAM INPUT 1	Connect external reference current
POWER ON Switch	ON. The POWER ON light and the display of the phase angle meter should illuminate.
PHASE SHIFTER ADJUSTMENT:	
COARSE	Position COARSE adjustment to the desired 60° segment.

FINE

Adjust FINE control to set the desired phase angle.

NOTE: When the FUNCTION Switch is positioned in the Ø-Ø position, PAM INPUT 2 of the phase angle meter is connected to primary of output phases I-II. This connection is the same shown in the Westinghouse instruction book for the KD series of relays.

BRUSH #1 and #2

A variable voltage is available at the output binding posts I and II. The magnitude of the I-II voltage is adjusted by rotating BRUSH #1 in a **clockwise** direction to obtain $^1/_2$ of the desired fault voltage and BRUSH #2 counterclockwise to obtain the total desired fault voltage.

NOTE: Moving the BRUSHES opposite to the manner described will result in reverse phase rotation. When it is desirable to make voltage II-III or voltage II-I the adjustable voltage, adjust the MODE Switch to the appropriate position and switch the EXT. VOLTMETER Switch to the appropriate position to read the magnitude of the voltage to be adjusted.

NOTE: Care should be exercised to make sure the voltmeter which is connected to the TO EXT. V.M. binding post is switched to the appropriate full scale range to read the magnitude of the voltage outputs. If it is desired to read the voltage on the unfaulted phases, the voltmeter should initially be in a 300 volt range to prevent overranging the meter.

VARIABLE, THREE-PHASE POTENTIAL OUTPUT

TYPICAL APPLICATION:	TESTING 3Ø voltage relays such as reverse phase, phase sequence and undervoltage, etc.

It is recommended that the test technician refer to the relay manufacturer's instruction book for details concerning the relay characteristics, type of tests and adjustment procedures for the specific relay under test.

INPUT VOLTAGE SELECTOR Switch	To appropriate position for power supply being used.
INPUT POWER binding posts	Normally, the phase angle meter would not be used with this output function. No input is required.
MODE Switch	BALANCED 3Ø ON.
OUTPUT FUNCTION Switch	Does not matter.
EXT.VOLTMETER Switch	I-II.
PAM INPUT 2 INTERNAL/EXTERNAL Switch	Does not matter.
BRUSH #1, #2, #3	Full counterclockwise rotation.
I, II, III output binding posts	Connect potential coils of relay.
TO EXT.V.M. binding posts	Connect external voltmeter with suitable ranges.
PHASE SHIFTER ADJUSTMENT COARSE	Does not matter.
BALANCED 3Ø control (same as PHASE SHIFTER ADJUSTMENT FINE)	Full counterclockwise rotation.
POWER ON Switch	ON. The POWER ON light and the phase angle meter display should illuminate.
BALANCED 3Ø control	A balanced three-phase potential is now available at output binding posts I, II, III. Ganged control of this potential is provided by adjusting the BALANCED 3Ø control clockwise. Voltages can be read by changing position of EXT.VOLTMETER Switch.

TO EXT. INITIATE binding posts	If it is desired to time a relay at zero volts, connect an external timer initiating circuit to the Blue binding posts labeled TO EXT. INITIATE.

When the MODE Switch is adjusted to the OFF position, the EXTERNAL timing circuit will be initiated at the same time the 3Ø potential output is reduced to zero.

The external timer initiate circuits on Models SR-51, SR-51A, SR-77 and SR-76A are ideally suited for this application. When using these models proceed as follows:

1. Follow preceding procedure for set-up of controls on Model CS-7B.

2. Connect Model SR-51, SR-51A, SR-77 or SR-76A to a suitable power supply.

3. Insert the telephone-type plug (test lead) which is supplied with Models SR-51, SR-51A, SR-77 or SR-76A into the EXT. INITIATE jack on these units and connect the other end of the test lead to the TO EXT. INITIATE binding posts on Model CS-7B.

4. Set the TIMER OPERATION SELECTOR (INITIATE CONTROL) knob (on Models SR-51, SR-51A, SR-77 or SR-76A) to the appropriate N. O. or N.C. position and the lever to the TIMER position.

5. Set the MODE Switch on Model CS-7B to the BALANCED 3Ø ON position.

6. Connect the trip circuit contacts of the relay under test to the RELAY CONTACTS binding posts on Model SR-51, SR-51A, SR-77 or SR-76A.

7. Turn POWER ON/OFF Switch on Model SR-51, SR-51A, SR-77 or SR-76A to ON. Reset timer.

8. Rotate the BALANCED 3Ø control (same as FINE control of PHASE SHIFTED ADJUSTMENT) on Model CS-7B to set the desired 3Ø test voltage.

9. Change MODE Switch to BALANCED 3Ø OFF. The output voltage of CS-7B will be reduced to zero and the timer on Model SR-51, SR-51A, SR-77 or SR-76A will simultaneously start.

10. The timer will stop when the relay contacts of the relay under TEST OPEN (or CLOSE).

COMMENTS ON CONDUCTING ANGLE OF MAXIMUM TORQUE TESTS

Model CS-7B utilizes a transformer-type, phase-shifting network to control the phase relationship. It is the nature of this circuit that the magnitude of the output potential will vary when the FINE control knob of the PHASE SHIFTER ADJUSTMENT is rotated. When the FINE control is at either end of its rotation, (fully counterclockwise or fully clockwise), the output voltage is at a maximum, assuming of course, that the voltage control BRUSHES are adjusted to obtain an output. As the FINE control is rotated from either extreme, the output voltage will decrease in magnitude until the FINE control is at the midpoint of its travel where the output voltage reaches a minimum. As rotation of the FINE control continues further in the same direction, the output voltage increases in magnitude until the control is again at the end of its travel. At this time, the voltage again reaches its maximum.

The amount of voltage change is proportional to the magnitude of the output voltage set with the BRUSHES, that is, the smaller the originally set output voltage, the less the voltage changes; and the higher the output voltage was set, the greater the voltage swing.

Basically, there are two different test procedures used for verifying the angle of maximum torque on directional distance or loss-of-excitation relays. The easiest method is to set two test angles equidistant (in degrees) from the desired angle of maximum torque, and then determine the reach of the relay at these two test angles. For example, if the relay's angle of maximum torque is supposed to be set at 75°, determine the reach at 45° and 105° (75° minus 30° and 75° plus 30°. If the angle of maximum torque is properly calibrated, the reach at both of the test angles will be equal. If they are not equal, the angle of maximum torque can be adjusted following the manufacturer's procedures. To use this method, the phase angle is set at the desired value, a fixed current (or potential) is applied and the potential (or current) is varied until the relay operates. This procedure is the easiest to perform because the phase angle is set; and therefore, the output potential does not change.

The second test method is more difficult to use since it calls for varying the phase angle thereby causing the test potential to also change. In this method, appropriate values of test potential and test current are applied to the relay, and the phase angle is adjusted in order to determine the phase angle where the relay just operates (picks-up). Since the phase angle is adjusted during this procedure, the output potential from the test set also varies and must be readjusted. If this method is utilized, it is suggested that the following procedure be followed.

1. Depending upon the type of relay to be tested, follow the appropriate test procedure (contained in the instruction manual for Model CS-7B) for the desired output to be obtained from the test set.

2. Based on the relay manufacturer's recommendations, apply the appropriate values of test potential and test current to the relay and adjust the PHASE SHIFTER ADJUSTMENT COARSE and FINE controls until the approximate angle of maximum torque is indicated on the phase angle meter.

3. Without adjusting the output BRUSHES, use the FINE, and if necessary, the COARSE controls to swing (adjust) the phase angle to one side of the angle of maximum torque until the relay just drops out.

4. Once drop-out has occurred, use the BRUSHES to re-adjust the potential to the desired test value. If appreciable adjustment of the potential is required, the relay will probably again close its contacts.

5. If the relay did again pick up, continue to swing the phase angle in the same direction until drop-out is again obtained, then check and again adjust output potential if necessary.

6. Usually it is necessary to make three or four adjustments of the phase angle and potential in order to determine the phase angle at which drop-out occurs at the desired values of potential and current.

7. Since angle of maximum torque is usually determined from pick-up of the relay rather than drop-out, adjust the phase angle in the same direction until the relay contacts are fully open, and then adjust the phase angle in the opposite direction until the contacts again close, indicating the relay has picked up. Again, verify the voltage and phase angle at which the relay contacts just close.

8. Find the phase angle on the other side of the angle of maximum torque where the relay just picks up by repeating the above procedures, except for adjusting the phase angle in the opposite direction.

9. Once the two phase angles at which the relay just picks up have been found, the angle of maximum torque can be calculated. If necessary, the angle of maximum torque can be adjusted in accordance with the manufacturer's recommended test procedure.

IMPORTANT: **It should be noted that both of the above are general purpose procedures. The relay manufacturer's instruction book should be consulted for specific methods, values, etc., applicable to each relay.**

TESTING DISTANCE RELAYS
GENERAL ELECTRIC TYPE GCX

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Tester

2. Multi-Amp Model CS-7B Phase Shifter and Phase Angle Meter

POWER REQUIRED

Input: 3-phase at approximately 200 VA for Model CS-7B.
120 volts, 60 Hz. 1-phase at approximately 1.4 KVA for Model SR-76A.

TYPES OF TESTS

1. Ohm unit tests - First (#1) zone reach and maximum torque angle

2. Ohm unit tests - Second (#2) zone reach

3. Starting - MHO unit tests - Third (#3) zone reach and maximum torque angle

4. Pick-up of OX relay

5. Pick-up of S relay

6. Pick-up of overcurrent unit

7. Pick-up of target and seal-in unit

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

The OHM unit (upper) spiral spring should barely hold the contact against the backstop.

The MHO unit (lower) spiral spring should hold the contact definitely open.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals, or

2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

3. If the relay is to be tested on the switchboard, remove plugs from the top and bottom of the unit and replace them with test plugs. Remove bottom plug first.

WARNING: During removal of cover and plugs, be careful not to activate the Target and Seal-In unit contacts as this can cause tripping of the circuit breaker.

4. Make sure the main switch on the CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3-phase power.

6. Connect Model SR-76A to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: Controls are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION
ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. Control Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C. or VERNIER Control	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-251/0-300VAC Switch	0-25A
A.C. AMMETER RANGE SWITCH	25A
0-25A or 0-300 VAC Control Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT Control Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

POWER	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As required
Mode Switch	NORM
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P. A. M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

TESTING OHM UNIT (Zone 1) FOR REACH AND PHASE ANGLE

1. Connect Model CS-7B output terminals labeled I and II to the relay potential terminals. Use lead from Terminal I as polarity.

2. Connect terminals labeled To EXT. V.M. on the CS-7B to terminals labeled EXT. A.C. on the SR-76A.

3. Connect main AC output current binding posts of the SR-76A to the relay current operating coil terminals. The relay contains two sets of current circuits. A jumper must be used so the current will flow through these circuits in series. The main AC current polarity terminal (+) must be connected to polarity terminal (+) of one set of the operating coils. Non-polarity terminal of this set of coils is jumpered to polarity terminal (+) of second set of relay operating coils. Non-polarity terminal of second set of relay operating coils is connected to non-polarity main output current terminal of SR-76A.

4. Plug the telephone type plug into the P.A.M Jack on SR-76A. Connect the leads from the plug to the CS-7B terminals marked P.A.M. INPUT #1/0.5-10A. Observe Polarity. Connect Black lead to terminal marked +.

5. Connect a pair of light leads from terminals marked RELAY CONTACTS (SR-76A) to terminals on relay so as to observe operation of OHM unit contacts.

6. Bypass or block closed, the overcurrent element contacts (if present) and the MHO unit contacts.

7. Turn POWER ON in the Models SR-76A and CS-7B. POWER ON lights should glow.

8. Initiate Model SR-76A by pressing the INITIATE pushbutton.

9. Adjust current through the current coils of the relay to desired value by turning the MAIN and VERNIER. Controls on SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and should be provided to the personnel performing the test). The CONTINUITY Light will glow.

10. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustments on the CS-7B to obtain the phase angle of the relay or value as determined from actual operating conditions (e.g. 90° - current lags voltage).

11. Rotate BRUSH #1 on the CS-7B clockwise to increase voltage until the CONTINUITY Light extinguishes. Continue to increase voltage until contacts open completely.

12. Reduce voltage slowly by rotating BRUSH #1 counterclockwise until the contacts of the OHM unit just close (as shown by the flickering of CONTINUITY Light).

13. Record the values of current and voltage. Compare with values computed and/or calibration data on the relay.

14. Return MAIN and VERNIER CONTROLS on SR-76A to zero (Maximum counterclockwise). Rotate BRUSH #1 on the CS-7B to the full counterclockwise position.

15. Steps 9 through 14 should be repeated at other values of phase angle equidistant and on either side of 90° I lag (i.e. 60° and 120° I lag) to determine angle of maximum torque.

16. Turn POWER ON Switches on SR-76A and CS-7B OFF.

TESTING OHM UNIT - (Zone 2) - FOR REACH

1. Repeat Steps 1 through 4 under "Testing Ohm Unit (Zone 1)".

2. Connect the SR-76A RELAY CONTACTS binding posts to relay terminals to observe operation of OHM unit and OX unit normally open contacts.

3. Close the OX relay contacts by blocking its armature in the closed position. (This is the relay mounted behind the nameplate).

4. Turn Models SR-76A and CS-7B POWER ON Switches to ON.

5. Initiate SR-76A by pressing INITIATE pushbutton.

6. Adjust current through the current coils of the relay to desired value by turning the MAIN and VERNIER CONTROLS on SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and should be provided to the personnel performing the test).

7. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustments on the CS-7B to obtain the phase angle of the relay or value as determined from actual operating conditions (e.g. 90° - current lags voltage).

8. Rotate BRUSH #1 on CS-7B clockwise to increase voltage until the CONTINUITY Light extinguishes. Continue to increase voltage until contacts open completely.

9. Reduce voltage slowly by rotating BRUSH #1 counterclockwise until the contacts of the OHM unit just close as shown by the flickering of the continuity light.

10 Record the values of current and voltage. Compare with values computed and/or calibration data on the relay.

11. Return MAIN and VERNIER Control on SR-76A to zero (Maximum counterclockwise). Rotate BRUSH #1 on CS-7B to full counterclockwise position.

12. If desired, steps 4 through 10 may be repeated at other values of phase angle equidistant and on either side of 90° I lag (i.e. 60° and 120° I lag).

13. Turn Models SR-76A and CS-7B OFF.

14. Remove blocking of MHO and OX units. Retain blocking on instantaneous overcurrent (if present).

TESTING MHO UNIT - (Starting Unit) - (Zone 3) FOR REACH AND MAXIMUM TORQUE ANGLE

1. Repeat Steps 1 through 4 under "Testing Ohm Unit - (Zone 1)".

2. Block OHM unit and O.C. unit closed.

3. Connect the SR-76A RELAY CONTACTS Binding Posts to relay terminals to observe operation of MHO unit contacts.

4. Turn POWER ON in Models SR-76A and CS-7B. POWER ON lights should glow.

5. Initiate Model SR-76A by pressing the INITIATE pushbutton.

6. Adjust current through the current coils of the relay to desired value by turning the MAIN and VERNIER CONTROLS on SR-76A slowly clockwise. CONTINUITY Light may glow. (The value of current will be calculated from the impedance settings of the relay and should be provided to the personnel performing the test).

7. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustments on the CS-7B to the phase angle of the relay or value as determined from actual operating conditions (e.g. 60° - current lags voltage).

8. Rotate BRUSH #1 on the CS-7B clockwise to increase voltage until the CONTINUITY Light glows. Continue to rotate BRUSH #1 until light extinguishes and relay contacts are fully open.

9. Reduce voltage slowly by rotating BRUSH #1 counterclockwise until the contacts of the MHO unit just close (as shown by flickering of the CONTINUITY Light).

10. Record the values of current and voltage.

11. Return MAIN and VERNIER CONTROLS on SR-76A to zero (Maximum counterclockwise). Rotate BRUSH #1 on CS-7B to the full counterclockwise position.

12. Steps 4 through 10 should be repeated at other values of phase angle equidistant and on either side of 60° I lag (i.e. 30° and 90° I lag) to determine angle of maximum torque.

13. Turn Models SR-76A and CS-7B OFF.

14. Remove all blocking from the relay.

TESTING OX UNIT

Model CS-7B not required.

SR-76A - SET-UP OF CONTROLS BEFORE TEST

1. Block MHO, OHM and overcurrent unit contacts closed.

2. Connect a pair of light leads to relay terminals which will energize OX unit coil.

3. Connect the other end of the leads to the AUXILIARY OUTPUT Red (+) and Black (-) binding posts of the AUXILIARY OUTPUT SELECTION.

4. Connect a pair of light leads from terminals marked RELAY CONTACTS to terminals of relay to observe opening of OX unit contacts.

5. Turn the POWER ON Switch to ON. POWER ON light and Continuity Light should glow.

6. Initiate the unit by pressing INITIATE pushbutton.

7. Rotate AUXILIARY OUTPUT CONTROL Knob slowly clockwise until the CONTINUITY Light is extinguished. Observe the voltage on the voltmeter. This is the pickup voltage value at the OX relay.

8. Return the AUXILIARY OUTPUT CONTROL Knob to zero (maximum counterclockwise).

9. Reconnect the leads from terminals marked RELAY CONTACTS to relay terminals to observe closure of OX unit contacts. CONTINUITY Light is extinguished.

10. Rotate AUXILIARY OUTPUT CONTROL Knob slowly clockwise until the CONTINUITY Light glows. Observe the pick-up voltage of the OX relay on the voltmeter.

11. Turn AUXILIARY OUTPUT CONTROL Knob slowly counterclockwise until CONTINUITY Light is extinguished. Observe the dropout voltage of the OX relay on the voltmeter.

12. Return the AUXILIARY OUTPUT CONTROL Knob to zero (maximum counterclockwise).

13. Turn Model SR-76A OFF.

14. Remove all blocking from the relay.

TESTING S RELAY

Model CS-7B not required.

SR-76A - SET-UP OF CONTROLS BEFORE TEST

Setup controls the same as for testing DC Auxiliary Relays, see pages 3-18 and 19 of the SR-76A instruction manual.

1. Connect a pair of light leads to relay terminals to energize S unit coil.

2. Connect the other end of the leads to the AUXILIARY OUTPUT Red (+) and Black (-) binding posts of the AUXILIARY OUTPUT SECTION.

3. Connect a pair of light leads from terminals marked RELAY CONTACTS to relay terminals so as to observe operation of S unit contacts.

4. Turn the POWER ON Switch to ON. POWER ON light should glow.

5. Initiate the unit by pressing INITIATE pushbutton.

6. Observe the CONTINUITY Light. Light should be extinguished.

7. Rotate AUXILIARY OUTPUT CONTROL Knob slowly clockwise until the CONTINUITY Light glows. Observe the pick-up voltage of the S relay on the voltmeter.

8. Turn AUXILIARY OUTPUT CONTROL Knob slowly counterclockwise and observe the dropout voltage of S relay as indicated when the CONTINUITY Light is extinguished.

9. Return the AUXILIARY OUTPUT CONTROL Knob to zero (maximum counterclockwise).

10. Turn Model SR-76A OFF.

OVERCURRENT UNIT TEST

Model CS-7B not required.

1. Block the OHM and MHO unit trip circuit contacts closed.

2. Connect a set of heavy leads (#10 or heavier) to relay terminals to energize overcurrent unit operating coil.

3. Connect the other end of these leads to the appropriate main AC current output terminals of the SR-76A.

4. Connect a pair of light leads from terminals marked RELAY CONTACTS to relay trip circuit terminals so as to observe operation of overcurrent unit contacts.

5. Turn the POWER ON Switch ON. POWER ON light should glow.

6. Initiate the unit by pressing INITIATE pushbutton.

7. Turn MAIN and VERNIER CONTROLs slowly clockwise until instantaneous element picks up. CONTINUITY Light should glow.

8. Read current on the ammeter. This is the pickup current of the instantaneous overcurrent element.

9. Return the MAIN and VERNIER CONTROLS to zero (maximum counterclockwise).

10. Turn the SR-76A OFF.

11. Remove all blocking from the relay.

TESTING OF TARGET AND SEAL-IN UNIT

Model CS-7B not required.

SR-76A - SET-UP OF CONTROLS BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
TONE/CONTINUITY Switch	Either Position
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	D.C.
MAIN A. C. CONTROL Knob	0
D. C./VERNIER Switch	D.C.
A. C. AMMETER RANGE Switch	As required
D. C. or VERNIER CONTROL Knob	0
D. C. AMMETER RANGE Switch	As required
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

1. Block the OHM, MHO and Instantaneous Overcurrent Element (when supplied) trip circuit contacts closed.

2. Connect a pair of light leads from terminals marked RELAY CONTACTS to relay trip circuit terminals so as to observe operation of seal-in contacts.

3. Connect a set of light leads to relay terminals associated with target and seal-in operating coil.

4. Connect other end of the leads to terminals marked 0-5A-DC.

5. Turn POWER ON Switch ON. POWER ON light should glow.

6. Initiate unit by pressing INITIATE Pushbutton.

7. Rotate VERNIER CONTROL slowly (clockwise) to increase output.

8. Observe Target Operation. When seal-in contacts close, the CONTINUITY Light will glow.

9. Read pick-up current on DC Ammeter.

10. Return the VERNIER CONTROL to zero (maximum counterclockwise).

11. Turn SR-76A OFF.

12. Remove all blocking from the relay.

TESTING OF OFFSET MHO BLOCKING RELAY G.E. TYPE CEB 12 AND CEB 51

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Tester.

2. Multi-Amp Model CS-7B Phase Shifter.

POWER REQUIRED

Input: 3Ø at approximately 200 VA for Model CS-7B
120 Volts, 60 Hz., 1Ø at approximately 1.4 kva for Model SR-76A

TYPE OF TESTS

1. MHO Unit Test - reach, maximum torque angle, and offset.
2. CEB 51 Diode Polarity Check.
3. Pick-up and timing of OB units.

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Relay Test Set.

2. Place the relay at a convenient location so that easy connections can be made to all terminals, or

2a. Place Model CS-7B and Relay Test Set close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

3. If the relay is to be tested on the switchboard, remove plugs from the top and bottom of the unit and replace them with test plugs. Remove bottom plug first.

   WARNING: During removal of cover and plugs, be careful not to activate the Target and Seal-in unit contacts as this can cause tripping of the circuit breaker.

4. Make sure the main switch on CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the units.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

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SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE SWITCH	25A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM.
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

POWER	POSITION
ON-OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As required
Mode Switch	I-II
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P. A. M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

TESTING MB UNIT FOR REACH, MAXIMUM TORQUE ANGLE AND OFFSET (MHO UNIT)

1. Connect terminals labeled "Voltage to External Meter" on CS-7B to EXT A.C. terminals of the SR-76A with a set of light leads.

2. Connect the relay potential coil terminals to Output Terminals I and II on the CS-7B. Terminal I is polarity on CS-7B.

3. Connect main AC current output of the control section of the SR-76A to the relay current operating coil terminals. The relay contains two current coils. A jumper must be used to have current flow through these coils. A jumper must be used to have current flow through these coils in series. This is accomplished by connecting the polarity terminal (±) of the main AC current output in the control section to the polarity terminal (±) of one of the operating coils. The NON-polarity terminal of this coil is jumpered to the polarity terminal (±) of the second operating coil. The NON-polarity terminal of the second coil is connected to the NON-polarity terminal of main AC current output of the SR-76A.

4. Plug the telephone type plug into the P.A.M. jack on SR-76A. Connect the leads from the plug to the CS-7B current terminals marked P.A.M. INPUT 1. Observe polarity. Connect Black lead to terminal marked ±.

5. Connect a pair of light leads from terminals marked RELAY CONTACTS (SR-76A) to terminals on relay so as to observe operation of MB Unit trip circuit contacts.

6. Turn Power ON in the Models SR-76A and CS-7B. Power ON lights should glow.

7. Initiate Model SR-76A by pressing the INITIATE pushbutton.

8. Adjust current through the current coils of the relay to desired value by turning the MAIN CONTROL on SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and will be provided to the personnel performing the test - suggested value 5 amps). The continuity light will glow. Fine adjustment of current is obtained by using VERNIER CONTROL in conjunction with the MAIN CONTROL on the SR-76A.

9. Adjust the phase angle by means of the COURSE and FINE phase shifter and adjustment on the CS-7B to the phase angle of the relay or value as determined from actual operating conditions (Example: 60° - current lags voltage). CONTINUITY light should glow.

10. Increase the voltage output by rotating BRUSH #1 on the CS-7B clockwise until the continuity light is extinguished. Continue to increase voltage 10/15 volts above this point and then decrease voltage until continuity light just lights by rotating BRUSH #1 clockwise then counterclockwise respectively.

11. Verify current and phase angle are as set in Steps 8 and 9. If necessary, make proper adjustments to re-establish them.

12. Record current, voltage, and phase angle where continuity light just lights as pick-up.

13. Return MAIN and VERNIER CONTROLS on SR-76A to zero (maximum counterclockwise). Rotate BRUSH #1 to its full counterclockwise position on the CS-7B.

14. Steps 8 through 13 should be repeated at other values of phase angle to determine angle of maximum torque. These values should be equidistant and on either side of maximum torque angle (i.e. 30 and 90 I lag).

15. To check OFF SET, repeat Steps 8 through 13 except the phase angle should be set 180 away from the angle set in Step 9. (Example: 240° current lag voltage).

16. Turn Power ON Switches on SR-76A and CS-7B OFF.

CEB - 51 DIODE POLARITY CHECK

Model CS-7B not required.

SR-76A SET-UP OF CONTROLS BEFORE TEST

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	250A
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	.5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

Testing Diode:

NOTE: Place DC tap link on relay in 250V DC.

1. Connect the SR-76A to a suitable source of power as indicated on the nameplate.

2. Connect a pair of light leads from the Black and Red 0-5A DC OUTPUT TERMINALS of the CONTROL Section to Terminals 1 and 2 of the relay. Connect the lead from the + binding post to terminal #2.

3. Turn the Power ON Switch ON. Power ON light should glow.

4. Initiate unit by pressing INITIATE Switch.

5. Rotate the DC-VERNIER CONTROL Knob clockwise until .04 amps DC is read on the DC ammeter.

6. Reverse the connections to the Terminals 1 and 2 of the relay. The DC ammeter should read zero.

7. Turn test set OFF and return DC control to zero.

PICKUP AND TIMING OF OB UNIT

Model CS-7B not required.

SR-76A SET-UP OF CONTROLS BEFORE TEST

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	250A
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	5A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	Aux. D.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM.
AUX. OUTPUT Voltage Selector Switch	0-150VDC
NORM./DROPOUT	NORM.

1. Block the MB trip circuit contacts closed.
2. Connect a pair of light leads from terminals marked RELAY CONTACTS to relay terminals to observe operation of OB unit normally open contacts.
3. Connect a pair of light leads the AUXILIARY OUTPUT (+) Red and (-) Black binding posts of the AUXILIARY OUTPUT SECTION to the relay terminals associated with the OB unit operating coil
4. Connect SR-76A to a suitable source of single phase, 120 volt power as indicated on nameplate.
5. Turn the Power ON Switch ON. POWER ON light should glow.
6. Initiate unit by pressing INITIATE switch.
7. Rotate Aux. Output CONTROL Knob clockwise until CONTINUITY Light glows. Read value of DC voltage indicated on Voltmeter required to just operate OB unit. This value should be 60-80% of DC voltage link position selected on relay.
8. To time OB unit increase DC voltage to rated value of DC link by rotating Aux. Output CONTROL Knob clockwise.
9. Turn test set off.

10. Place Initiate CONTROL Knob in N.O. MOM.; Initiate CONTROL Lever in TIMER positions.

11. Turn Power ON Switch ON. Power ON light should glow.

12. Initiate test set by pressing and holding Initiate Switch.

13. When timer stops release Initiate Switch. Timer indicates time of OB unit operation.

14. Turn Power ON Switch OFF.

OFFSET MHO DISTANCE RELAY G. E. CEB 52
MHO DISTANCE RELAY G.E. TYPES CEY 51 AND CEY 52

These relays are all three-phase, high speed, single zone MHO directional relays. To follow these instructions when testing these relays, the manufacturer's instruction books must be available. For CEY 52 Book No. GEK 1291A, CEY 51 Book No. GEK 1275, CEY 52 Book NO. GEK 1289.

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Tester.

2. Multi-Amp Model CS-7B Phase Shifter.

POWER REQUIRED

Input: 3Ø at approximately 200 VA for Model CS-7B.
120 VOLTS, 60 Hz., 1Ø for Model SR-76A.

TYPE OF TESTS

1. MHO Unit Test - Ø 1-2 reach, torque angle and offset (CEB).

2. MHO Unit Test - Ø 2-3 reach, torque angle and offset (CEB).

3. MHO Unit Test - Ø 3-1 reach, torque angle and offset (CEB).

4. Pick-up of target and seal-in unit.

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures and relay connections as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals, or

2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

3. If the relay is to be tested on the switchboard, remove plugs from the top and bottom of the unit, and replace them with test plugs. Remove the bottom plug first.
WARNING: During removal of cover and plugs, be careful not to activate the Target and Seal-in unit contacts as this can cause tripping of the circuit breaker.

4. Make sure the main switch on CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

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SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE SWITCH	25A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

POWER	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As required
Mode Switch	I-II
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P. A. M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

NOTE: Relay Terminals 6, 8 and 10 must be connected together by jumpers throughout the entire testing of the relay.

TESTING Ø 1-2 UNIT FOR REACH, ANGLE OR MAXIMUM TORQUE AND OFFSET

1. Connect terminals labeled VOLTAGE to EXTERNAL METER on CS-7B to EXT A.C. terminals of the SR-76A with a set of light leads.

2. Connect the I and II terminals of the CS-7B to the relay potential coil terminals. Refer to the tables in the relay manufacturer's instruction book, columns "Lead A" and "Lead B". The I terminal of the CS-7B is polarity (±) and should be connected to relay terminal(s) under column "Lead A".

3. Connect main AC current output of the SR-76A to the relay operating coil terminals as indicated in the tables in the relay manufacturer's instruction book, columns "Lead C" and "Lead D". The polarity (±) terminal of main AC current output should be connected to the relay terminal in column "Lead C".

4. Plug the telephone type plug into the P.A.M. jack on SR-76A. Connect the leads from the plug to the CS-7B terminals marked P.A.M. Input #1 0.5-10A. Observe polarity. Connect Black lead to terminal marked (±).

5. Connect a pair of light leads from terminals marked RELAY CONTACT (SR-76A) to terminals on relay so as to observe operation of Ø 1-2 unit trip circuit contacts.

6. Turn Power ON Switches in the Models SR-76A and CS-7B to ON. Power ON lights should glow.

7. Initiate Model SR-76A by pressing the INITIATE pushbutton.

8. Adjust current through the current coils of the relay to desired value by turning the MAIN CONTROL on SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and will be provided to the personnel performing the test). The CONTINUITY light will glow. Final adjustment of current is obtained by using Vernier CONTROL Knob in conjunction with the MAIN CONTROL on the SR-76A (suggest 5-10 amps).

9. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustment on the CS-7B to the relay angle of maximum torque (Example: 75° - current lags voltage for CEB relay and 60° current lags for CEY relay).

10. Increase the voltage output by rotating BRUSH #1 on the CS-7B clockwise until the CONTINUITY light is extinguished. Continue to increase voltage 10/15 volts above this point and then decrease voltage until CONTINUITY light just lights by rotating BRUSH #1 clockwise then counterclockwise, respectively.

11. Verify current and phase angle are set as in Steps 8 and 9. If necessary, make proper adjustments to re-establish them.

12. Record current, voltage, and phase angle where continuity light just glows as pickup.

13. Return MAIN and VERNIER CONTROLs on SR-76A to zero (maximum counterclockwise). Rotate BRUSH #1 to its full counterclockwise position on the CS-7B.

14. To determine the relay angle of maximum torque, repeat Steps 8 through 13 for a phase angle 180° away from angle used in Step 9. (Example: 255° current lag voltage).

16. Turn Power ON Switches OFF, both SR-76A and CS-7B.

TEST Ø 2-3 UNIT FOR REACH, ANGLE MAXIMUM TORQUE AND OFFSET

1. Repeat Steps 1 through 16 above except main AC current output terminals of SR-76A and terminals I and II on the CS-7B are connected to relay terminals designated in the relay manufacturer's instruction book for "Middle Ø 2-3 Unit".

2. In Step 5 above, connect the light leads from SR-76A RELAY CONTACTS binding posts to observe operation of relay Ø 2-3 unit trip circuit contacts.

TEST Ø 3-1 UNIT FOR REACH, ANGLE MAXIMUM TORQUE AND OFFSET

1. Repeat Steps 1 through 16 above except main AC current output terminals of SR-76A and I and II terminals of CS-7B are connected to relay terminals designated in the relay manufacturer's instruction book for "Bottom Ø 3-1 Unit".

2. In Step 5 above, connect the light leads from SR-76A RELAY CONTACTS binding posts to observe operation of relay Ø 3-1 Unit trip circuit contacts.

TESTING TARGET AND SEAL-IN UNIT

Model CS-7B not required.
Aux. Output Section of SR-76A not required.

SETUP OF CONTROLS ON CONTROL SECTION SR-76A
ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	DC
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	250A
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

1. Connect SR-76A to a suitable source of single phase, 120 volt, 60 cycle power.

2. Block unit Ø 1-2 trip circuit contacts closed.

3. Connect a pair of light leads from SR-76A terminals marked RELAY CONTACTS to relay terminals 1 and 11, jumper relay terminals 1 and 12.

4. Turn SR-76A Power ON Switch ON.

5. Initiate SR-76A by pressing INITIATE Switch.

6. Rotate DC Vernier control clockwise until relay target drops and seal-in contacts should remain closed.

8. Read and record value of pick-up current.

9. Return DC Vernier CONTROL to full counterclockwise position.

10. Turn SR-76A OFF.

11. Repeat Steps 1 through 10 above for unit ØN 2-3 trip circuit, except RELAY CONTACTS binding posts are connected to relay terminals 11 and 2; jumper relay terminals 2 and 12; block relay unit Ø 2-3 trip circuit contacts closed.

12. Repeat Steps 1 through 10 above for unit Ø 3-1 trip circuit, except, RELAY CONTACTS binding posts are connected to relay terminals 11 and 3; jumper terminals 12 and 3; block relay unit Ø 3-1 trip circuit contacts closed.

TESTING DISTANCE RELAYS
GENERAL ELECTRIC TYPE GCY

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Tester

2. Multi-Amp Model CS-7B Phase Shifter

POWER REQUIRED

Input: 3Ø at approximately 200 VA for Model CS-7B.
120 volts, 60 Hz., 1Ø at approximately 1.4 kVA for Model SR-76A

TYPES OF TESTS

1. MHO Unit Test - First (#1) zone reach and torque angle.
2. MHO Unit Test - Second (#2) zone reach and torque angle.
3. MHO Unit Test - Third (#3) zone reach, maximum torque angle and offset.
4. Pick-up of target and seal-in unit.

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals, or

2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

3. If the relay is to be tested on the switchboard, remove plugs from the top and bottom of the unit and replace them with test plugs. Remove bottom plug first.

   WARNING: During removal of cover and plugs, be careful not to activate the Target and Seal-in unit contacts as this can cause tripping of the circuit breaker.

4. Make sure the main switch on CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLs are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION
ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC/NORMAL Switch	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-251/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	25A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

POWER	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As required
Mode Switch	NORM
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P. A. M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

TESTING M-1 UNIT (Zone 1) FOR REACH AND PHASE ANGLE

1. Connect terminals labeled To EXT. V.M. on CS-7B to EXT. AC terminals of the SR-76A (Unit 2) with a set of light leads.

2. Connect the relay potential coil terminals to Output Terminals I and II on the CS-7B. Terminal I is polarity on CS-7B.

3. Connect main AC current output of the SR-76A to the relay current operating coil terminals. The relay contains three current coils. Jumpers must be used to have current flow through these coils in series. This is accomplished by connecting the polarity terminal (±) of the main AC current output to the polarity terminal (±) of one of the operating coils. The NON-polarity terminal of this coil is jumpered to the polarity terminal (±) of the second operating coil. The NON-polarity terminal of this coil is jumpered to the polarity terminal (±) of the second operating coil. The NON-polarity terminal of the third coil is connected to the NON-polarity terminal of the main AC current output.

4. Plug the telephone type plug into the P.A.M. jack on the SR-76A. Connect the leads from the plug to the CS-7B terminals marked P.A.M. Input #1/0.5-10A. Observe polarity. Connect Black lead to terminal marked ±.

5. Connect a pair of light leads from terminals marked RELAY CONTACTS (SR-76A) to terminals on relay so as to observe operation of M-1 unit trip circuit contacts.

6. Turn power ON in the Models SR-76A and CS-7B. Power ON lights should glow.

7. Initiate Model SR-76A by pressing the INITIATE pushbutton.

8. Adjust current through the current coils of the relay to desired value by turning the MAIN CONTROL knob of the SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and should be provided to the personnel performing the test). The continuity light may glow. Fine adjustment of current is obtained by using Vernier CONTROL in conjunction with the MAIN CONTROL knob on the SR-76A.

9. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustment on the CS-7B to the phase angle of the relay or value as determined from actual operating conditions (example - 60° current lags voltage).

10. Increase the voltage output by rotating BRUSH #1 on the CS-7B clockwise until the continuity light is extinguished. Continue to increase voltage 10/15 volts above this point and then decrease voltage until continuity light just lights by rotating BRUSH #1 clockwise then counterclockwise respectively.

11. Verify current and phase angle are as set in Steps 8 and 9. If necessary, make proper adjustments to re-establish them.

12. Record current, voltage, and phase angle where continuity light just lights as pickup.

13. Return MAIN and VERNIER CONTROLS on SR-76A to zero (maximum counterclockwise). Rotate BRUSH #1 to its full counterclockwise position on the CS-7B.

14. Steps 8 through 13 should be repeated at other values of phase angle to determine angle of maximum torque. These values should be equidistant and on either side of max. torque angle (i.e. 30° and 90° I lag).

15. Turn Power ON Switches on SR-76A and CS-7B OFF.

TESTING M-2 UNIT - (Zone 2) - FOR REACH AND PHASE ANGLE

1. Repeat steps 1 through 4 of testing M-1 unit.

2. Reconnect leads from terminals marked RELAY CONTACTS on the SR-76A to observe operation of the M-2 unit (2nd Zone) trip circuit contacts.

3. Turn Models SR-76A by pressing INITIATE pushbutton.

5. Adjust current through the current coils of the relay to desired value by turning the MAIN CURRENT CONTROL Knob on SR-76A slowly clockwise. (The value of current will be calculated from the impedance setting of the relay and should be provided to the personnel performing the test.) Fine adjustments of current may be obtained by use of the Vernier CONTROL on the SR-76A.

6. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustment on the CS-7B to the phase angle of the relay or value as determined from actual operating conditions (Example - 75° - current lags voltage).

7. Increase the voltage output by rotating BRUSH #1 on the CS-7B clockwise until the continuity light is extinguished. Continue to increase voltage 10/15 volts above this point and then decrease voltage until continuity light just lights by rotating BRUSH #1 (CS-7B) clockwise then counterclockwise respectively.

8. Verify current and phase angle are as set in Steps 5 and 6. If necessary, make proper adjustments to re-establish them.

9. Record current, voltage, and phase angle where continuity light just lights as pickup.

10. Repeat Steps 4 through 8 at other values of phase angle equidistant and on either side of angle of maximum torque (i.e. 45° and 105° I lag) to determine angle of max. torque.

11. Return MAIN and VERNIER CONTROLS on SR-76A to zero (Maximum counterclockwise). Rotate BRUSH #1 to full counterclockwise position on CS-7B.

12. Turn both Test Sets OFF.

TESTING OM-3 UNIT - (Zone 3) FOR REACH AND PHASE ANGLE

1. Repeat steps 1 through 4 of testing M-1 unit.

2. Reconnect leads from terminals marked RELAY CONTACTS (SR-76A) to observe operation of OM-3 unit trip circuit contacts of the relay.

3. Turn Power ON in Models SR-76A and CS-7B. Power ON lights should glow.

4. Initiate Model SR-76A by pressing the INITIATE pushbutton.

5. Adjust current through the current coils of the relay to desired value by turning the MAIN CURRENT CONTROL Knob on SR-76A slowly clockwise. (The value of current will be calculated from the impedance settings of the relay and should be provided to the personnel performing the test). Fine adjustment of the current may be obtained by use of the AUX. CONTROL (SR-76A).

6. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustment on the CS-7B to the phase angle of the relay or value as determined from actual operating conditions (Example - 75° - current lags voltage).

7. Increase the voltage output by rotating BRUSH #1 on the CS-7B clockwise until the continuity light is extinguished. Continue to increase voltage 10/15 volts above this point and then decrease voltage until continuity light just lights by rotating BRUSH #1 clockwise then counterclockwise respectively.

8. Verify current and phase angle are as set in steps 5 and 6. If necessary, make proper adjustments to re-establish them.

9. Record current, voltage, and phase angle where continuity light just lights as pickup.

10. Return MAIN and VERNIER CONTROLS on SR-76A to zero (Maximum Counterclockwise). Rotate BRUSH #1 to full counterclockwise position on the CS-7B.

11. Steps 3 through 9 should be repeated at other values of phase angle to determine angle of maximum torque. These values should be equidistant and on either side of angle of maximum torque (i.e. 45° and 105° I lag).

12. Turn Models SR-76A and CS-7B OFF.

TESTING OF TARGET AND SEAL-IN UNIT

Model CS-7B not required.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLs are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	DC
TONE/CONTINUITY Switch	Either position
MAIN C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	DC
A. C. AMMETER RANGE Switch	Any range (not used)
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	To appropriate range

1. Block the M-1 trip circuit contacts closed.

2. Connect a pair of light leads from terminals marked RELAY CONTACTS (SR-76A) to Relay Terminals 1 and 11.

3. Connect a set of light leads to relay terminals associated with target and seal-in operating coil.

4. Connect the other end of these leads to terminals marked "0-5A D.C.".

5. Turn POWER ON Switch ON. POWER ON light should glow.

7. Rotate D.C. or VERNIER slowly (clockwise) to increase output.

8. Observe target operation. When seal-in contacts close, continuity light will glow.

9. Read pickup current on DC Ammeter.

10. Return the D.C. or VERNIER CONTROL to zero (maximum counterclockwise).

11. Turn SR-76A OFF.

12. Remove all blocking from the relay.

TESTING DIRECTIONAL GROUND DISTANCE RELAY
GENERAL ELECTRIC TYPE GCXG

REFER TO THE MANUFACTURER'S INSTRUCTION BOOK BEFORE PROCEEDING WITH TEST.

EQUIPMENT REQUIRED

1. Multi-Amp Models SR-76A Relay Tester.

2. Multi-Amp Model CS-7B Phase Shifter.

POWER REQUIRED

Input: 3 - phase at approximately 200VA for Model CS-7B.
120 volts, 60 cycles, 1-phase at approximately 1.4 kva for Model SR-76A.

TYPE OF TESTS

1. OHM Unit Tests - First (#1) zone reach and maximum torque angle.

2. OHM Unit Tests - Second (#2) zone reach.

3. Starting Unit Test - Third (#3) zone reach and maximum torque angle.

4. Pick-up of OX relay.

5. Pick-up of target and seal-in unit.

6. Over-all test.

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical test. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required.) Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of the Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals or

   2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

3. If the relay is to be tested on the switchboard, remove plugs from the top and bottom of the unit and replace them with test plugs. Remove bottom plug first.

WARNING: During removal of cover and plugs, be careful not to activate the target and Seal-In unit contacts as this can cause tripping of the circuit breaker.

4. Be sure the main switches of the CS-7B and SR-76A are in the OFF position.

5. Connect Model CS-7B to a suitable source of 3-phase power.

6. Connect Model SR-76A to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE SWITCH	25A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM

AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

POWER	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As required
Mode Switch	NORM
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P. A. M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

TESTING OHM UNIT (Zone 1) FOR REACH AND PHASE ANGLE

1. Connect Model CS-7B output binding posts I and II to the relay potential coil terminals. Observe polarity (Output terminal I on CS-7B is polarity. Terminal 17 is relay polarity).

2. Connect a set of light leads from Model CS-7B binding posts labeled TO EXT. V.M., to the terminals labeled EXT. A.C., on Unit 2 Model SR-76A.

3. The relay contains two sets of current coils. A jumper must be used so the current will flow through these sets of coils in series. This is accomplished by connecting the main AC Current Output common polarity terminal (±) (SR-76A) to the polarity terminal (±) of one set of the operating coils. NON-polarity terminal of this set of coils is jumpered to polarity terminal (±) of second set of relay operating coils. NON-polarity terminal of second set of relay operating coils is connected to NON-polarity terminal of main AC Current Output i.e. 0-160V/8.75A.

4. Plug the telephone type plug into the P.A.M. jack on SR-76A. Connect the leads from the plug to the CS-7B terminals marked PAM INPUT #1/0.5 - 10A. Black lead goes to ± terminal to observe polarity.

5. Connect a pair of light leads from terminals marked RELAY CONTACTS on SR-76A to appropriate relay terminals to observe operation of OHM unit contacts (1st zone).

6. Turn POWER ON Switches to ON on Models SR-76A and CS-7B. The POWER ON light (SR-76A) and the Red light on the CS-7B should glow.

7. Initiate Model SR-76A by pressing the INITIATE pushbutton.

8. Adjust current through the current coils of the relay to desired value by rotating the MAIN CONTROL Knob on the SR-76A slowly clockwise. Fine adjustment of current is possible by using the VERNIER CONTROL Knob in conjunction with the MAIN CONTROL. (The value of current will be calculated from the impedance settings of the relay and will be provided to the personnel performing the test.) The continuity light will glow.

9. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustments on the CS-7B to obtain the desired phase angle for this test (e.g. 90° current lags voltage).

10. Rotate BRUSH #1 on CS-7B clockwise until the continuity light extinguishes. Continue to increase voltage until contacts open completely.

11. reduce voltage slowly by rotating BRUSH #1 counterclockwise (CS-7B) until the contacts of the ohm unit just close (as shown by the flickering of the continuity light).

12. Record the values of current, voltage and phase angle. Compare with values computed and/or calibrated data for the relay.

13. Return the MAIN and VERNIER CONTROLs on the SR-76A and BRUSH #1 on the CS-7B to Zero (full counterclockwise rotation).

14. To check the angle of maximum torque, repeat steps 8 - 13, at two other phase angle relationships, each displaced from nominal maximum of 90° current lag by 30°; -- that is, at 60° I lag and 120° I lag. The two values of voltage obtained should be equal.

15. Turn POWER ON Switches on SR-76A and CS-7B OFF.

TESTING OHM UNIT (Zone 2) - FOR REACH

1. The light leads from the terminals marked Relay Contacts on the SR-76A must be changed at the relay terminals to observe closure of the OHM unit and OX unit normally open contacts.

2. Close the OX relay contacts by blocking its armature in the closed position. (This is the relay mounted behind the nameplate).

3. Turn POWER ON Switches to ON on Models CS-7B and SR-76A.

4. Initiate SR-76A by pressing INITIATE pushbutton.

5. Adjust current through current coils of the relay to desired value by rotating the MAIN and VERNIER CONTROLs on the SR-76A slowly clockwise. (This value of current is calculated from the impedance settings of the relay and normally will be provided to the personnel performing the test).

6. Adjust the COARSE and FINE phase shifter adjustments on the CS-7B to obtain the phase angle required for this test (e.g. 90° I lag).

7. Rotate BRUSH #1 on CS-7B until the continuity light extinguishes. Continue to increase voltage until contacts open completely.

8. Reduce voltage slowly by rotating BRUSH #1 counterclockwise (CS-7B) until contacts of the OHM unit just close as shown by the flickering of the continuity light (SR-76A).

9. Record values of current, voltage and phase angle. Compare with computed and/or calibration data for the relay.

10. Return MAIN and VERNIER CONTROLS (SR-76A) and BRUSH #1 (CS-7B) to zero (maximum counterclockwise rotation).

11. Turn Models SR-76A and CS-7B OFF.

12. Remove blocking from OX unit of relay.

TESTING STARTING UNIT - (Zone #3) REACH AND ANGLE OF MAXIMUM TORQUE

1. The light leads from the terminals marked RELAY CONTACTS (SR-76A) must be changed at the relay terminals to observe closure of the starting unit contacts.

2. Leaving existing connections to the relay as they are (refer to Steps 1 through 4 under "Testing OHM Unit Zone #1.") connect a pair of light leads from binding posts labeled III and IV (CS-7B) to the starting unit potential polarizing coil of relay. Connect IV (CS-7B) to terminal 19 of relay to have polarizing voltage lagging voltage output I-II by 90°.

3. Turn POWER ON Switches to ON (CS-7B and SR-76A).

4. Initiate Model SR-76A by pressing INITIATE pushbutton.

5. Adjust current through current coils of relay to desired value by rotating MAIN and VERNIER CONTROLS on the SR-76A clockwise. (The value of current is calculated from the impedance settings of the relay and is normally provided for the personnel performing the test.)

6. Adjust the phase angle by means of the COARSE and FINE phase shifter adjustments (CS-7B) to the phase angle of the relay or values as determined from actual operating conditions (e.g. 60° I lag).

7. Rotate BRUSH #2 clockwise (CS-7B) to obtain desired starting unit polarizing voltage magnitude (120 volts). The III-IV voltage magnitude and phase angle relationship to the current may be read by turning VOLTAGE to EXTERNAL METER Switch (CS-7B) to position III-IV.

8. Turn EXT. VOLTMETER Switch (CS-7B) to position I-II and rotate BRUSH #1 clockwise (CS-7B) until continuity light glows (SR-76A). Continue to rotate BRUSH #1 clockwise until light extinguishes and relay contacts are fully open.

9. Reduce voltage (I-II) slowly by rotating BRUSH #1 counterclockwise until contacts of starting unit just close (as shown by flickering of the continuity light).

10. Record values of voltages, current and phase angles.

11. Return MAIN CONTROL and VERNIER CONTROL (SR-76A) and BRUSHES #1 and #2 (CS-7B) to zero (maximum counterclockwise rotation).

12. To check the angle of maximum torque, repeat steps 5-11 for two other phase angles equidistant and on either side of the angle of maximum torque (e.g. 30° I lag and 90° I lag).

13. Turn POWER ON Switches to OFF (SR-76A and CS-7B).

TESTING OX UNIT

Model CS-7B not required.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
TONE/CONTINUITY Switch	Either position
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
MAIN A. C. CONTROL Knob	0
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C./VERNIER Switch	D. C.
D. C. or VERNIER CONTROL Knob	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-300VAC/0-25A Switch	0-300VAC
A.C. AMMETER RANGE Switch	25A
0-25A or 0-300 VAC CONTROL Knob	0
VOLTMETER RANGE Switch	So that the desired test voltage can be read in the upper 1/3 of the meter scale.
NORMAL/EXT. POWER INPUT Switch	NORMAL
V. RLY/DET Switch	NORM.
VOLTMETER CIRCUIT SELECTOR Switch	AUX. D.C.
AUXILIARY OUTPUT CONTROL Knob	0
AUXILIARY OUTPUT Selector Switch	Either 150VDC or 300 VDC
NORM./DROPOUT	NORM.
NORM./BYPASS Switch	NORM

1. Block OHM unit trip circuit contacts closed (top unit).

2. Connect a pair of light leads to relay terminals which will energize OX unit coil.

3. Connect a pair of light leads from terminals marked Relay Contacts to terminals of relay to observe opening of OX unit contacts.

5. Turn the POWER ON Switch to ON. POWER ON light and CONTINUITY Light should glow.

6. Initiate the unit by pressing INITIATE pushbutton.

7. Advance AUXILIARY OUTPUT CONTROL Knob slowly clockwise until the continuity light is extinguished. Observe the voltage on the voltmeter. This is the pick-up voltage value of the OX relay.

8. Return the AUXILIARY OUTPUT CONTROL Knob to zero (maximum counterclockwise).

9. Reconnect the leads from terminals marked RELAY CONTACTS to relay terminals to observe closure of the OX relay on the voltmeter.

10. Turn AUXILIARY OUTPUT CONTROL Knob slowly counterclockwise until continuity light is extinguished. Observe the dropout voltage of the OX relay on the voltmeter.

11. Return the AUXILIARY OUTPUT CONTROL Knob to zero (maximum counterclockwise).

12. Turn Model SR-76A OFF.

13. Remove all blocking from the relay.

TESTING DC TARGET AND SEAL IN

CS-7B not required.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
TONE/CONTINUITY Switch	Either position
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
MAIN A. C. CONTROL Knob	0
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C./VERNIER Switch	D. C.
D. C. or VERNIER CONTROL Knob	0
D. C. AMMETER RANGE Switch	5A
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-300VAC/0-25A Switch	0-300VAC
A.C. AMMETER RANGE SWITCH	25A
0-25A or 0-300 VAC CONTROL Knob	0
VOLTMETER RANGE Switch	So that the desired test voltage can be read in the upper 1/3 of the meter scale.
NORMAL/EXT. POWER INPUT Switch	NORMAL
V. RLY/DET Switch	NORM.
VOLTMETER CIRCUIT SELECTOR Switch	AUX. D.C.
AUXILIARY OUTPUT CONTROL Knob	0
AUXILIARY OUTPUT Selector Switch	Either 150VDC or 300 VDC
NORM./DROPOUT NORM./BYPASS Switch	NORM. NORM

1. Block the starting unit contacts closed.
2. Connect a pair of light leads from terminals marked RELAY CONTACTS to relay terminals to observe operation of seal-in contacts.
3. Connect a set of light leads to relay terminals to energize target and seal-in coil.
4. Connect the other end of these leads to terminals marked 0-5A D.C.
5. Turn POWER ON Switch ON. POWER ON Light should glow.
6. Initiate unit by pressing INITIATE pushbutton.
7. Rotate D.C. or VERNIER CONTROL Knob slowly (clockwise) to increase output.
8. Observe Target Operation; seal-in contacts will light continuity light.
9. Read pickup current on DC Ammeter.

TESTING SYNCHRONISM - CHECK RELAYS
GENERAL ELECTRIC TYPE IJS
WESTINGHOUSE TYPE CVE

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Tester.

2. Multi-Amp Model CS-7A Phase Shifter.

POWER REQUIRED

Input: 3Ø at approximately 200 VA for Model CS-7B.
120 volts, 60 Hz. 1Ø at approximately 1.4 kva for Model SR-76A.

TYPES OF TESTS

1. Pick-up of Induction Disc.
2. Timing of Induction Disc.

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals.

3. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so that the test lead length is kept to a minimum and the relay operation can be observed during testing.

4. Be sure the main switch on CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of single phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the unit.

SETUP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A. C. CONTROL Knob	0 (counterclockwise)
D. C./VERNIER Switch	VERNIER
A. C. AMMETER RANGE Switch	So that reading will be in upper 1/3 of meter scale
D. C./VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A
HARMONIC/NORMAL Switch	NORMAL
	NORMAL

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	25A
0-25A or 0-300 VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
VOLTMETER CIRCUIT SELECTOR	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM
AUXILIARY OUTPUT Voltage Selector Switch	0 -300VAC
NORM./DROPOUT	NORM.

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CS-7B SET-UP OF CONTROLS BEFORE TEST

CONTROL	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage SElector Switch	As required
Mode Switch	NORM
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P.A.M. INT./EXT. Switch	INTERNAL
Output Function Switch	1Ø Test
External Voltmeter Switch	I - II

TESTING PICK-UP OF INDUCTION DISC

1. Connect Model CS-7B output terminals labeled I and II to one of the relay potential coil terminals. Use lead from Terminal I as polarity.

2. Connect terminals labeled TO EXT. V.M. on the CS-7B to terminals labeled EXT. A.C. on the AUXILIARY OUTPUT Section of the SR-76A.

3. Connect Model SR-76A 0-300 VAC output terminals on Unit 2 to the other relay potential coil terminals. Observe polarity.

4. Connect another set of leads from the 0-300 VAC output terminals to CS-7B PAM INPUT #1/10-250V input observe polarity.

5. Connect a pair of light leads from terminals marked RELAY CONTACTS to the contact circuit of relay.

6. Turn POWER ON Switches on Models SR-76A and CS-7B ON. POWER ON lights should glow.

7. Initiate Model SR-76A by pressing the INITIATE pushbutton.

8. Rotate BRUSH #1 (CS-7B) clockwise to obtain rated voltage to the relay potential coil.

9. Turn Voltmeter Circuit Selector Switch to 300 VAC position. Rotate 0-25A or 0-300VAC CONTROL Knob clockwise to obtain rated voltage to the second relay potential coil.

10. Adjust the COARSE and FINE controls on the CS-7B until the phase angle meter reads zero; continuity light should glow. Continue to rotate these controls until the continuity light flickers for a lagging phase angle. Record this reading of the phase angle meter. Repeat for leading phase angle.

    NOTE: Refer to the relay manufacturer's instruction book for any necessary adjustment.

TIMING OF INDUCTION DISC

1. Repeat Steps 1 through 9 under "Pick-Up of Induction Disc".

2. Adjust CS-7B to obtain 0° phase angle between the voltages being applied to the relay's potential coils. Deinitiate the output by switching the INITIATE CONTROL Knob from N.O. MAINT. to N.O. MOM., back to N.O. MAINT. POSITION.

3. Set the INITIATE CONTROL LEVER to TIMER. Reset timer and make sure relay has returned to its de-energized position before continuing with Step 4.

4. Initiate test by pushing INITIATE pushbutton. Record results and check with the manufacturer's specifications.

TESTING POWER RELAYS
GENERAL ELECTRIC TYPE ICW
WESTINGHOUSE TYPE CW

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Test Set.

2. Multi-Amp Model CS-7B Combined Phase-Shifter and Phase-Angle Meter.

POWER REQUIRED

Input: 3Ø at approximately 200 VA for Model CS-7B.
120 volts, 60 cycles, 1Ø at approximately 1.0kVA for Model SR-76A.

TYPES OF TESTS

1. Minimum pickup.

2. Timing.

GENERAL

The General Electric Type ICW or Westinghouse Type CW relay is an induction disc relay containing current and voltage operating coils. It is a single phase wattmeter element equipped with a tap block so that minimum operating watts may be varied. The operation of these relays depends upon both phase angle and the magnitude of the applied voltage and current. Either the ICW or CW relay is available as a 3-phase or 1-phase unit.

The 3-phase relay measures 3-phase watts, and the current coil is connected to the secondary winding of a current transformer in one phase. The relay potential coil is connected to the secondary winding of a potential transformer providing line to line voltage. The tap block of this relay is calibrated in 3-phase watts. $W=1.73$ EI (Power Factor).

TESTING GE TYPE ICW 51A RELAY (CALIBRATED IN 3-PHASE WATTS).

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals.

   OR

2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so relay operation can be observed during testing.

3. If the relay is to be tested in the switchboard, open test switches at the top and bottom of the unit and replace them with test plugs. Open Red Switch first.

WARNING: During removal of cover, be careful not to activate the Target and Seal-In Unit contacts as this can cause tripping of the circuit breakers.

4. Be sure the main switch on the CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single-phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the unit.

SET-UP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A.C. CONTROL Knob	0 (counterclockwise)
D.C./VERNIER Switch	VERNIER
A.C. AMMETER RANGE Switch	So that reading will be in upper $^1/_3$ of meter scale
D. C. or VERNIER CONTROL	0
D. C. AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	25A
0-25A or 0-300VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT.PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM.
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

CONTROL	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As Required
Mode Switch	I-II
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P.A.M. INT./EXT. Switch	INT
OUTPUT FUNCTION Switch	1Ø Test
EXTERNAL VOLTMETER Switch	I-II

TESTING MINIMUM PICKUP

1. Connect a set of light leads from EXT VM binding posts (SR-76A) to the TO EXT. V.M. binding posts (CS-7B).

2. Plug the telephone type plug into the P.A.M. Jack (SR-76A). Connect the leads from the plug to the CS-7B binding posts marked P.A.M. Input #1 0.5 - 10A Terminals. (Black lead goes to the $\pm$ terminal).

3. Connect SR-76A main output current binding posts to relay terminals so that the relay current coil may be energized. Observe polarity.

4. Connect binding post I and II (CS-7B) to the relay potential coil. Terminal I is polarity.

5. Connect a pair of light leads from the SR-76A binding posts marked RELAY CONTACTS to the relay trip circuit contacts terminals.

6. Turn SR-76A and CS-7B POWER ON Switches ON. POWER ON lights should glow.

7. Initiate SR-76A by pressing the INITIATE Switch.

8. Rotate the SR-76A MAIN CONTROL clockwise to energize the relay current coil, until the main ammeter indicates 5 amperes.

9. Adjust the COARSE and FINE Controls (CS-7B) until the Phase Angle Meter indicates 270° current lags voltage.

10. Rotate BRUSH #1 (CS-7B) clockwise until the CONTINUITY light (SR-76A) flickers. Observe the value of voltage.

11. If the relay is in perfect adjustment, the value of voltage observed in Step 10 should be:

$$E = \frac{\text{Relay Tap Value}}{(1.73)\ (5)} = _____ \text{ Volts}$$

12. Turn both test sets OFF.

TESTING TIMING

1. Repeat Steps 1-10 above (Testing Minimum Pickup).

2. Rotate BRUSH #1 (CS-7B) clockwise until the voltmeter indicates a value of voltage equivalent to:

$$E = \frac{(4)\ (\text{Relay Tap Setting})}{(1.73)\quad (\text{I Relay})} = ____ \text{ Volts}$$

If this value of voltage exceeds the relay voltage rating, rotate MAIN CONTROL (SR-76A) to increase current input to relay.

Then adjust BRUSH #1 so that:

$$E = \frac{(4)\ (\text{Relay Tap Setting})}{(1.73)\ (\text{I Relay})} = ___ \text{ Volts}$$

3. Turn SR-76A POWER ON Switch OFF.

4. Adjust Timer Operation Selector Switch, Upper to N.O. MAINT., Lower to TIMER.

5. Turn SR-76A POWER ON Switch ON.

6. Reset Timer to zero.

7. Initiate SR-76A by pressing INITIATE Switch.

8. When relay trip circuit contacts make, the timer will stop and the relay will be de-energized. Read and record this value of time.

9. Turn both test sets OFF.

TESTING WESTINGHOUSE TYPE CW RELAY 30° CHARACTERISTIC (CALIBRATED IN 3-PHASE WATTS)

Follow exactly the same procedure as for General Electric Type ICW 51A except as noted below:

1. The CS-7B controls should be adjusted until the Phase Angle meter reads current lagging voltage by 330°.

TESTING GENERAL ELECTRIC TYPE ICW51D OR WESTINGHOUSE CW ZERO DEGREE CHARACTERISTIC. (CALIBRATED IN SINGLE-PHASE WATTS)

Follow exactly the same procedure as for Type ICW51A except as noted below:

1. The CS-7B controls should be adjusted until the phase angle meter reads zero (voltage and current in phase).

2. In calculating the test voltages, use the formula:

   Watts = (Voltage) (Current)

   Where watts = tap value or multiple thereof

   Current = Reading of MAIN AMMETER or magnitude of current energizing relay current coil from SR-76A.

FIELD TESTING OF
WESTINGHOUSE KD COMPENSATOR DISTANCE RELAYS

Refer to the manufacturer's instruction Book for values of current, voltage, and phase angles applicable to the relay under test, as these values will change with relay reach and model.

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Test Set.

2. Multi-Amp Model CS-7B Combined Phase-Shifter and Phase-Angle Meter.

POWER REQUIRED

Input: 3Ø at approximately 200VA for Model CS-7B.

120 volts, 60 cycles, 1Ø at approximately 1.0kVA for Model SR-76A.

TYPES OF TESTS

1. Angle Maximum Torque
   a. 3Ø unit
   b. Ø - Ø unit

2. Minimum Pick-Up (Reach) 3Ø Unit.

3. Minimum Pick-Up (Reach) Ø - Ø Unit
   a. Phase 1 - 2
   b. Phase 2 - 3
   c. Phase 3 - 1

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

Calculation of Test Values of Voltage and Current for Relay Tap Settings (Typical)

3 Phase Unit

$$Z = \frac{TS}{1 \pm M} \text{ ohms}$$

Where:

T = Compensator Tap Value

S = Autotransformer primary tap value

$\pm M$ = Autotransformer secondary tap value (this is a per unit value and is determined by the algebraic sum of the values between L and R. This sign is positive when L is above R and negative when R is above L.

The impedance (Z) is also equal to

$$\frac{\text{Voltage (L-N)}}{\text{I (L)}} \times \frac{\text{Sin } \emptyset}{\text{Sin } 75^\circ}$$

Where: Ø is desired phase angle (Current Lag) between voltage and current used to energize relay coils. 75° (Current Lag) is design angle of maximum torque of relay.

Example:

T = 6.1

S = 1

M = +0.15

V (L-L) = 30, therefore, V (L-N) = $\frac{30}{3}$ = 17.35

Ø = 75° current lag

$$\frac{6.1 \times 1}{1 + 0.15} = \frac{17.35}{I} \times \frac{\text{Sin } 75^\circ}{\text{Sin } 75^\circ}$$

$$I = \frac{17.35 \times 1.15}{6.1} = 3.26 \text{ Amps minimum}$$

Current to operate 3Ø unit under the above conditions of tap settings, voltage, and phase angle (Tolerance + 5%).

Phase to Phase Unit

$$Z = \frac{TS}{1 \pm M} \text{ OHMS}$$

T, S, and M have the same definitions as for 3Ø unit.

Impedance (Z) is also equal to

$$\frac{\text{Voltage (L-L)}}{2I\ (L)} \times \frac{\text{Sin } Ø}{\text{Sin } 75°}$$

Example:

T = 6.1

S = 1

M = +0.15

V (L-L) = 30

Ø = 75° current lag

$$\frac{6.1 \times 1}{1 + 0.15} = \frac{30}{2I} \times \frac{\text{Sin } 75°}{\text{Sin } 75°}$$

$$I = \frac{30 \times 1.15}{2 \times 6.1 \times 1} = 2.8 \text{ Amps minimum}$$

Current to operate Ø - Ø unit under the above conditions of tap settings.
Voltage and Phase Angle (Tolerance + 7.5%)

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals.

   OR

   2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so relay operation can be observed during testing.

3. If the relay is to be tested in the switchboard, open test switches at the top and bottom of the unit and replace them with test plugs. Open Red switch first.

   WARNING: **During removal of cover, be careful not to activate the Target and Seal-In Unit contacts as this can cause tripping of the circuit breakers.**

4. Make sure that the main switch on CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single-phase power as indicated on the nameplate.

7. Set-up of controls - SR-76A

SET-UP OF CONTROLS ON CONTROL SECTION
ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A.C. CONTROL Knob	0 (counterclockwise)
D.C./VERNIER Switch	VERNIER
A.C. AMMETER RANGE Switch	So that reading will be in upper $^1/_3$ of meter scale
D.C. or VERNIER CONTROL	0
D.C. AMMETER RANGE Switch	5A

Part No. 12435
Rev. 1 8/14/91

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	25A
0-25A or 0-300VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR. Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM.
AUX. OUTPUT Voltage Selector Switch	0-150VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

CONTROL	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As Required
Mode Switch	I - II
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P.A.M. INT./EXT. Switch	INT
Output Function Switch	3Ø Delta
External Voltmeter Switch	I - II

PRELIMINARY RELAY CONNECTIONS

1. Jumper terminal 12 to 19.

2. Jumper terminals 14, 16, and 18.
   NOTE: These terminals will remain jumpered throughout all tests.

ANGLE MAXIMUM TORQUE - 3Ø UNIT

REFER TO THE MANUFACTURER'S INSTRUCTIONS FOR TAP SETTINGS FOR YOUR APPLICATION OF RELAY.

1. Connect Model CS-7B output binding posts marked I , II and III to relay voltage coil terminals 7, 8, and 9 respectively.

2. Connect binding posts marked TO EXT. V.M. on CS-7B to EXT. V.M. binding posts of SR-76A with a pair of light leads.

3. Plug the telephone type plug into the P.A.M. Jack on SR-76A. Connect the leads from the plug to the CS-7B binding posts marked P.A.M. INPUT # 1/0.5-10A (Black lead goes to (±) terminal).

4. Connect a pair of light leads from terminals marked Relay Contacts on SR-76A to proper terminals on relay to observe operation of three-phase unit contacts.

5. Connect main AC current output of SR-76A to relay current coil terminals for three-phase test. Polarity terminals (±) of main AC current output is connected to terminal #13 of the relay. Non-polarity terminal of main AC current output is connected to terminal #18 of relay.

6. Turn POWER ON Switches of SR-76A and CS-7B to ON. POWER ON lights should glow.

7. Initiate SR-76A by pressing INITIATE pushbutton.

8. Adjust voltage on relay terminals to 120 volts phase-to-phase. Using CS-7B, rotate BRUSH #1 clockwise until I-II voltage reads 120 volts. Position EXT. VOLTMETER Switch to II-III and adjust BRUSH #2 until 120 volts is read on external voltmeter. Voltage III-I will now be 120 volts and may be read on external meter when EXT.VOLTMETER Switch is in the III-I position.

9. Check impedance units of the relay for restraining torque. If restraining torque is not present, rotation of phases is incorrect.

10. Rotate MAIN and VERNIER CONTROLS on SR-76A clockwise until current read on main ammeter is approximately 15% higher than **minimum** current calculated for 3Ø test.

11. Adjust phase-angle meter by the FINE and COARSE adjustments on CS-7B to read the desired maximum torque angle used in calculations plus 30°. For example, if desired maximum torque angle is 75° (Current Lag), set phase-angle meter to 105° (Current Lag).

12. Adjust voltage on relay terminals to desired value of line-to-line fault voltage (same as value used in calculations) by rotating BRUSH #1 (for V_{I-III}) and BRUSH #2 (for V_{II-III}). Read line-to-line voltages on external voltmeter by moving EXT. VOLTMETER Switch (CS-7B to appropriate positions. CONTINUITY light should glow or signal sounds.

13. To verify the ANGLE of MAXIMUM TORQUE slowly rotate the COARSE and FINE phase shifter adjustments on the CS-7B to decrease the phase angle, set in Step 11, until the CONTINUITY light flickers or tone signal breaks. During these operations the magnitude of the voltage and current may change, suitable adjustments should be made so the values of voltage and current set in Steps 10 and 12 are re-established. Record the reading of the phase angle meter ($Ø_1$). Now increase the phase angle to find the other point where the CONTINUITY light flickers or tone signal breaks. Before the phase angle meter is read, re-establish proper values of voltage, current, and the flickering continuity light. Record this reading of phase angle meter ($Ø_2$).

Angle Max. Torque = $\frac{Ø_1 + Ø_2}{2} - 30°$

Consult the manufacturer's data for proper adjustment.

Minimum Pick-Up (Reach) 3Ø Unit

1. Set-up of controls of test sets and connections to relay are the same as ANGLE MAXIMUM TORQUE - 3Ø UNIT.

2. Turn POWER ON on both test sets, initiate SR-76A.

3. Rotate MAIN and VERNIER CONTROLS on SR-76A clockwise until the current on main ammeter is approximately 75% of **minimum** current calculated for 3Ø test.

4. Repeating Steps 11 and 12 under "Angle Maximum Torque - 3Ø Unit" set phase angle and voltage (L-L) to values used in calculations. CONTINUITY Light should be extinguished.

5. Rotate VERNIER CONTROL on SR-76A clockwise to increase current until CONTINUITY light flickers or tone signal sounds.

   NOTE: Voltage and phase angle may need to be re-established to proper value. Current read when CONTINUITY light flickers should be the same (without tolerance) as minimum calculated current.

6. Make suitable adjustments to relay if necessary.

Angle of Maximum Torque - Phase-Phase Unit (1-2, 3-1)

Set-Up of controls on test sets and connections to relay same as for angle maximum torque 3Ø test except continuity light is connected to observe operation of Ø-Ø unit contacts.

1. Turn POWER ON on both test sets and initiate SR-76A.

2. Rotate MAIN and VERNIER CONTROLS on SR-76A until the main ammeter reads a value 250% of main current calculated to operate the Ø-Ø unit.

3. Repeat steps 11-13 of "Angle Maximum Torque - 3Ø Unit", except in step 11 when setting phase angle, do not add 30° to maximum angle of torque, i.e., 75°. In step 13, do not subtract 30°.

Angle of Maximum Torque Ø-Ø = $\frac{Ø_1 + Ø_2}{2}$

4. Turn off test sets and move the polarity lead from SR-76A main AC current output to relay terminal #17 from Relay Terminal 13 and from relay terminal 18 to relay terminal 13.

5. Repeat Steps 1 - 3 of the Angle Maximum Torque Ø-Ø Unit.

6. Turn power OFF on both test sets.

Minimum Pick-Up (Reach) Ø - Ø Unit (Phase 1-2)

1. Connect Model CS-7B output binding posts marked I, II, III to relay voltage coil terminals 7, 8, and 9 respectively. Connect SR-76A AC current output to appropriate relay current coils; polarity (±) to relay terminal 13, non-polarity to relay terminal 15.

2. Connect a pair of light leads from binding posts labeled TO EXT. V.M. on CS-7B to EXT. V.M.) binding posts on SR-76A.

3. Connect a pair of light leads from terminals marked RELAY Contacts on SR-76A to proper terminals on relay to observe operation or Ø - Ø unit contacts.

4. Set Function Switch on CS-7B to Ø-Ø position. Set Mode Switch to I-II position.

5. Turn POWER ON Switches of SR-76A and CS-7B to ON. POWER ON Lights should glow.

6. Initiate SR-76A by pressing INITIATE pushbutton.

7. Adjust BRUSH #1 on CS-7B in a clockwise rotation to obtain $^1/_2$ of desired fault voltage (phase I-II voltage). Adjust BRUSH #2 on CS-7B in a counterclockwise rotation to obtain total desired fault voltage.

   NOTE: Adjusting BRUSHES in opposition to manner described results in ACB phase rotation. Voltage should be same as used in calculations.

8. With the above conditions set, the upper unit contact on the relay should be slight restraint.

9. Rotate MAIN and VERNIER CONTROLS of SR-76A clockwise to give approximately 2 amperes output.

10. Adjust phase angle to desired maximum torque angle used in calculations by rotating COARSE and FINE adjustments on CS-7B. (Do not add 30°; set directly to desired angle).

11. Adjust VERNIER CONTROL of SR-76A clockwise until CONTINUITY light just flickers or tone signal sounds.

NOTE: Phase angle and voltage may have to be re-established to proper value. Read and record current where continuity light just flickers. Value of current should check (within tolerance) minimum calculated current.

12. Make suitable adjustments to relay if necessary, and repeat Step 10.

13. Turn both test sets OFF.

Minimum Pick-Up Ø - Ø (Phase 2-3)

1. Connect main AC current output of SR-76A to appropriate relay current coil, Polarity (+) to relay terminal 15, non-polarity to 17.

2. Turn MODE and EXT. VOLTMETER Switches on CS-7B to II-III position. This places fault voltage, adjustable by BRUSHES #1 and #2 between output terminals II and III. A slight adjustment of voltage and/or phase angle may be required due to difference in impedance of relay coils.

3. Follow test procedures as described in Steps 1-13, Ø - Ø Test for MINIMUM Pick-Up (Phase 1-2).

Minimum Pick-Up Ø - Ø (Phase 3-1)

1. Connect main AC current output of SR-76A to appropriate relay current coil. Polarity (+) to relay terminal 17, non-polarity to 13.

2. Turn MODE and EXT. VOLTMETER Switches on CS-7B to III-I position. This place fault voltage, adjustable by BRUSHES #1 and #2, between output terminals III and I. A slight adjustment of voltage and/or phase angle may be required due to difference in relay coil impedances.

3. Follow procedures as described in Steps 1-13, Ø - Ø Test for MINIMUM Pick-Up (Phase 1-2).

FIELD TESTS OF
POWER DIRECTIONAL RELAY
G.E. TYPE GGP

Refer to the manufacturer's instruction book for values of current, voltage, and phase angles applicable to the relay under test, as these values will change with relay reach and model.

EQUIPMENT REQUIRED

1. Multi-Amp Model SR-76A Relay Test Set.

2. Multi-Amp Model CS-7B Combined Phase-Shifter and Phase-Angle Meter.

POWER REQUIRED

Input: 3Ø at approximately 200VA for Model CS-7B.
120 volts, 60 cycles, 1Ø at approximately 1.0kVA for Model SR-76A.

TYPES OF TESTS

1. Maximum Angle of Torque

2. Pick-Up (Upper Unit)

3. Time Test (Upper Unit)

4. Target and Holding Coil

GENERAL

All mechanical maintenance and adjustments should be performed prior to the electrical tests. Follow recommended procedures as outlined in the manufacturer's instruction bulletin (except when As Found tests are required).

Relay must be level for tests.

SET-UP OF EQUIPMENT BEFORE TEST

1. Place Model CS-7B to the left of Model SR-76A.

2. Place the relay at a convenient location so that easy connections can be made to all terminals.

   OR

   2a. Place Model CS-7B and Model SR-76A close to the relay at the switchboard so relay operation can be observed during testing.

3. If the relay is to be tested in the switchboard, open test switches at the top and bottom of the unit and replace them with test plugs. **Open Red switch first.**

WARNING: During removal of cover, be careful not to activate the Target and Seal-In Unit contacts as this can cause tripping of the circuit breakers.

4. Be sure the main switch on the CS-7B and SR-76A are OFF.

5. Connect Model CS-7B to a suitable source of 3Ø power.

6. Connect Model SR-76A to a suitable source of single-phase power as indicated on the nameplate.

SR-76A SET-UP OF CONTROLS BEFORE TESTS

NOTE: CONTROLS are listed in order starting at the left-hand side of the unit.

SET-UP OF CONTROLS ON CONTROL SECTION

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

CONTROL	POSITION
POWER ON/OFF Switch	OFF
INITIATE CONTROL Knob	N.O. MAINT.
INITIATE CONTROL Lever	CONT.
TONE/CONTINUITY Switch	Either position
MAIN A.C. CONTROL Knob	0 (counterclockwise)
D.C./VERNIER Switch	VERNIER
A.C. AMMETER RANGE Switch	So that reading will be in upper $^1/_3$ of meter scale
D.C. or VERNIER CONTROL	0
D.C. AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON AUXILIARY SECTION

CONTROL	POSITION
0-25A/0-300VAC Switch	0-25A
A.C. AMMETER RANGE Switch	25A
0-25A of 0-300VAC CONTROL Knob	0 (counterclockwise)
VOLTMETER RANGE Switch	As required
NORMAL/EXT. PWR Switch	Normal
VOLTMETER CIRCUIT SELECTOR Switch	EXT. A.C.
AUXILIARY OUTPUT CONTROL Knob	0 (counterclockwise)
NORM./BYPASS Switch	NORM
AUX. OUTPUT Voltage Selector Switch	0-300VAC
NORM./DROPOUT	NORM.

CS-7B SET-UP OF CONTROLS BEFORE TEST

CONTROL	POSITION
ON/OFF Switch	OFF
Phase Shifter Adjustment FINE	Counterclockwise
Input Voltage Selector Switch	As Required
Mode Switch	I - II
Phase Shifter Adjustment COARSE	A
BRUSHES #1, 2, 3	Counterclockwise
P.A.M. INT./EXT. Switch	INT
Output Function Switch	1Ø Test
EXTERNAL VOLTMETER Switch	I - II

Angle of Maximum Torque

REFER TO THE MANUFACTURER'S INSTRUCTIONS FOR ADJUSTMENTS AND RELAY SCHEMATICS.

1. Connect a set of leads from the CS-7B I and II binding posts to the relay potential coils and connected in parallel. To observe polarity, connect I to relay terminals 14, 15, 18 and 19; connect II to relay terminals 13, 16, 17 and 20.

2. Connect binding posts marked TO EXT. V.M. on CS-7B to EXT. V.M. binding posts of SR-76A with a pair of light leads.

3. Plug the telephone type plug into the P.A.M. jack on SR-76A. Connect the leads from the plug to the CS-7B binding posts marked P.A.M. INPUT #1/0.5-10A (Black lead goes to ($\pm$) terminal).

4. Connect a set of leads from the SR-76A Relay Contacts binding post to the relay normally open trip circuit contact terminals, normally terminals 9 and 10.

5. Connect a set of leads from SR-76A MAIN CURRENT OUTPUT terminals to the relay current coils connected in series. To observe polarity, connect 0-160 volt/8.75A output tap to relay terminal 3. Jumper from 4 to 6, 5 to 7, and return from terminal 8 to $\pm$ common on relay test set.

6. Turn POWER ON Switches of SR-76A and CS-7B to ON. POWER ON lights should glow.

7. Initiate SR-76A by pressing INITIATE pushbutton.

8. Adjust voltage impressed on relay terminals to rated voltage. Using the CS-7B, rotate BRUSH #1 clockwise to increase voltage until external voltmeter indicates 120 or 208 volts.

9. Rotate MAIN and VERNIER CONTROLS on SR-76A clockwise until current read on main ammeter is approximately 5 amperes.

10. To verify the "Angle of Maximum Torque" slowly rotate the COARSE and FINE phase shifter adjustments on the CS-7B to decrease the phase angle until the CONTINUITY light flickers or tone signal sounds. During these operations, the magnitude of the voltage and current may change, suitable adjustments should be made so the values of voltage and current set in Steps 8 and 9 are re-established. Record the reading of the phase angle meter ($\emptyset_1$). Now increase the phase angle to find the other point where the CONTINUITY light flickers. Before the phase angle meter is read, re-establish proper values of voltage, current, and the flickering CONTINUITY light. Record this reading of phase angle meter ($\emptyset_2$).

11. The relay angle of maximum torque is the middle of the arc through which the relay trip contacts were closed as determined in steps 9 and 10. Maximum torque should be approximately 30°.

12. Turn the test sets off.

PICK-UP (UPPER UNIT) (CS-7B Not Required for this test)

1. Set up of controls on CONTROL Section does not change from the Maximum Angle of Torque Test.

2. Switch the VOLTMETER CIRCUIT Selector Switch to AUX. A.C. position. Switch the AUXILIARY OUTPUT Selector Switch to either the 0-150 VAC or 0-300 VAC position (depending on the nominal operating voltage of the relay).

3. Connect Model SR-76A to a suitable source of power in accordance with nameplate. Be sure the ON/OFF Switch is OFF.

4. Interconnect the relay operating coil (normally terminals 2 and 12) to the Red and Black binding posts under the AUXILIARY OUTPUT Section.

6. Connect light leads from binding posts marked RELAY CONTACTS to the trip circuit contact terminals of the relay induction unit (normally terminals 1 and 11).

7. Switch POWER ON/OFF Switch ON. POWER ON light should glow.

8. Initiate unit by pressing the INITIATE Switch.

9. Rotate the AUXILIARY OUTPUT Control knob (clockwise) to increase output until CONTINUITY light flickers or TONE output breaks.

10. Record this value of voltage as pickup of the relay. Return CONTROL Knob to zero.

TESTING TIMING (UPPER UNIT)

1. Switch the INITIATE CONTROL lever to TIMER and switch the V. RLY. Test Switch to FAULT position.

2. Set Normal relay voltage (120 or 208 volts) by rotating AUXILIARY OUTPUT control knob to increase output. Read the voltage on the voltmeter.

   NOTE: Set the voltage approximately 1 to 2 volts higher than the desired test voltage (i.e. 122 or 210 volts).

3. Switch the V. RLY. Test Switch to the TEST position. The voltage set in Step 2 will be impressed on the relay operating coil and the digital timer will automatically start.

4. When the relay trip circuit contacts make, the timer will stop to indicate the elapsed time of the test.

5. Record trip time and return CONTROL Knob to zero.

TARGET AND HOLDING COILS TEST

CS-7B is not required for this test

1. Connect the SR-76A to a suitable source of power. Check POWER-ON Switch to insure it is in the OFF position.

2. Connect a set of leads from the SR-76A RELAY CONTACTS terminals to the relay normally open trip circuit contact terminals.

3. Block the relay normally open trip circuit contacts closed.

4. Switch the D.C./VERNIER Switch to D.C. Adjust the INITIATE CONTROL Lever to the D.C. position.

5. Turn the POWER ON Switch ON. POWER ON Light should glow.

6. Initiate the SR-76A by pressing the INITIATE Switch.

7. Rotate the VERNIER CONTROL clockwise until the relay target operates.

8. Carefully remove the blocking from the relay without disturbing the trip circuit contacts. If holding coil is working, relay contact will not open.

9. Turn POWER ON Switch OFF and return all controls to zero.

SERVICE DATA

Servicing

The test set utilizes straightforward circuits and components which require little or no service except for routine cleaning, tightening of connections, etc. The test set should be serviced in a clean atmosphere away from energized electrical circuits. The following maintenance is recommended:

1. Open the unit every six months and examine for:

   a. dirt/dust

   b. moisture

   c. corrosion

2. Remove dirt/dust with dry, compressed air.

3. Remove moisture as much as possible by putting test set in a warm, dry environment.

4. As corrosion my take many forms, no specific recommendations can be made for its removal. However, it is suggested that the relay contacts be burnished using a diamond burnishing tool or an extra fine sand paper.

5. Check ribbon/cable connections for solid connections and printed circuit boards.

Service and Repair Order Instructions

If factory service is required or desired, contact the factory for return instructions.

A Service & Repair Order (SRO) number will be assigned for proper handling of the unit when it arrives at the factory.

If desired, a letter with the number and instructions can be provided.

Provide the factory with model number, serial number, nature of the problem or service desired, return address, your name, and where you can be reached should the factory need to contact you.

A purchase order number, cost limit, billing, and return shipping instructions may also be provided if desired.

National Bureau of Standards traceable calibration and certification of two types is available, if desired, at additional cost.

Class One: A certificate is provided verifying the traceability and calibration of the equipment.

Class N: That which is required for nuclear power plants. A certificate of traceability and calibration along with As Found and As Left data are provided.

If an estimate is requested, provide the name and contact information of the person with approval/disapproval authority.

Pack the equipment appropriately to prevent damage during shipment. If a reusable crate or container is used, the unit will be returned in it if in suitable condition.

Put the SRO number on the address label of the shipping container for proper identification and faster handling.

NOTE: Ship the equipment *without* instruction manuals or nonessential items such as test leads, spare fuses, etc. These items are not needed to conduct repairs. *Do* ship the equipment with *all* interconnect cables, etc. which make the unit operational.

Preparation for Reshipment

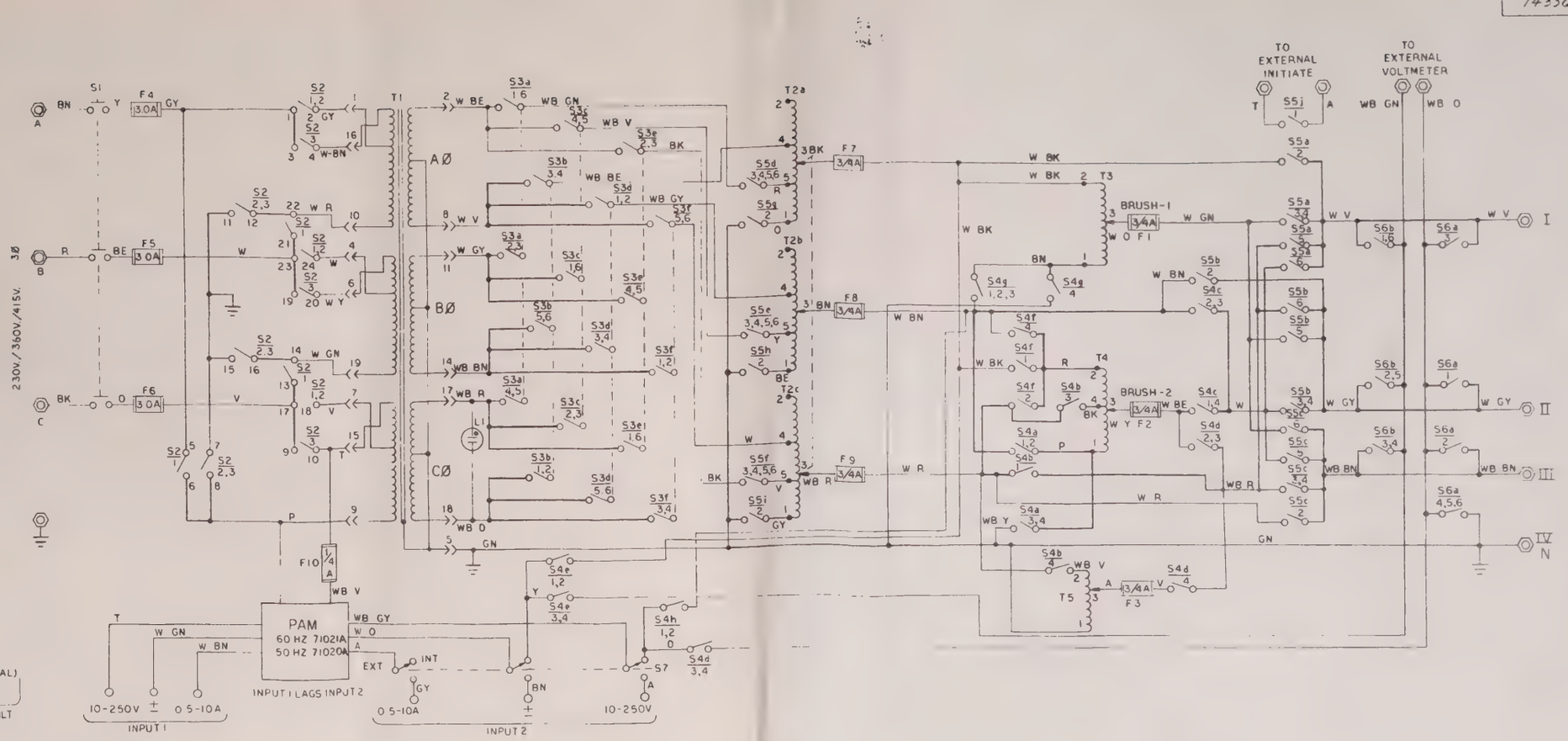
Save the shipping container that your unit came in. The shipping container your unit came in is designed to withstand the normal bumps and shocks of shipping via common commercial carrier. For example, you may wish to reship your unit to Multi-Amp for annual calibration certification.

Warranty Statement

Multi-Amp Corporation warrants to the original purchaser that the product is free from defects in material and workmanship for a period of one (1) year from date of shipment. This warranty is limited and shall not apply to equipment which has damage, or cause of defect, due to accident, negligence, unauthorized modifications, improper operation, faulty installation by purchaser, or improper service or repair by any person, company or corporation not authorized by the Multi-Amp Corporation.

Multi-Amp Corporation will, at its' option, either repair or replace those parts and/or materials that it deems to be defective. Any costs incurred by the purchaser for the repair or replacement of such parts and/or materials shall be the sole responsibility of the original purchaser.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED ON THE PART OF THE MULTI-AMP CORPORATION, AND IN NO EVENT SHALL THE MULTI-AMP CORPORATION BE LIABLE FOR THE CONSEQUENTIAL DAMAGES DUE TO THE BREACH THEREOF.



ITEM	PART NO	DESCRIPTION	QTY
L1	3	LAMP	1
T3,5	3726	VARIABLE TRANSF.	2
PAM	71020A	DIGITAL PAM 50 HZ	1
F10	7443	FUSE 1/4 A 250V	1
F4-6	8900	FUSE 3.0A FNQ	3
F1-3,7-9	2679	FUSE 3/4A 250V	6
	1403	SOCKET	1
	1404	PLUG	1
	945	FUSEHOLDER 3AG,V	7
	954	FUSEHOLDER 6AG,V	3
L1	6	LAMPHOLDER	1
PAM	71021A	DIGITAL PAM 60 HZ	1
S7	36	PAN ENT.-OFF SW.	1
6	709	EXT VOLTMETER SW.	1
5	3371	MODE SW	1
4	3372	FUNCTION SW	1
3	770	COARSE RHEO SW	1
2	3378	INPUT SELECTOR SW	1
S1	4535 4794	INPUT SW	1
T4	26834	1Ø 1AH TRANSF.	1
T2	2681	3Ø 1AH TRANSF	1
T1	6085	TRANSFORMER	1

NO	NO
1	1836 6-5-76
2	1875 7-12-76
3	1968 10-11-76
4	3160 4-6-77
5	3339 9-14-77
6	10208 9-3-81
7	13143 3-21-83
8	14106 9-15-83

14336 D

SERIAL # 22394 AND UP

THE DEVICE DEPICTED AND DESCRIBED HEREON EMBODIES PROPRIETARY DESIGN OWNED BY MULTI-AMP CORP. ALL DESIGN MANUFACTURING, REPRODUCTION SALES AND PATENT RIGHTS REGARDING THIS DEVICE OR DRAWING ARE RESERVED EXCEPT WHERE EXPLICIT RIGHT IS GRANTED IN WRITING.

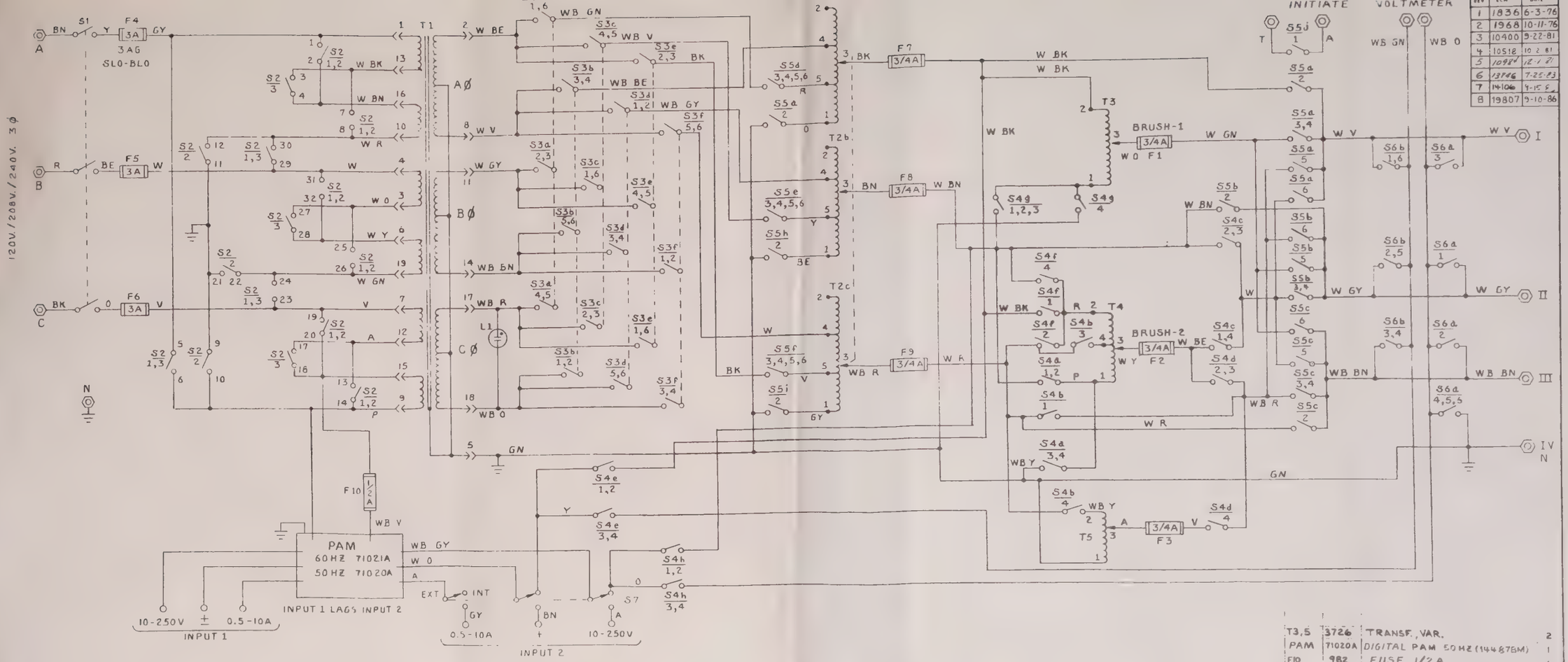
multi-amp

TOLERANCES
DECIMAL ± .010
FRACTIONAL 1/64
UNLESS NOTED

TITLE SCHEMATIC

PART NO 230V/380V/415V

14336 D 8



1	1836	6-3-76	
2	1968	10-11-76	
3	10400	3-22-81	
4	10518	10-2-81	
5	10984	12-1-81	
6	13746	7-25-83	
7	14106	4-15-8[illegible]	
8	19807	9-10-86	

S2 INPUT VOLTAGE

POS.	VOLTAGE
1	120V
2	208V
3	240V

S3 SWITCH (COARSE)

POS. A-4
B-3
C-2
D-1
E-6
F-5

SECTIONS a,b,c,d,e,f

S4 SWITCH (FUNCTION)

POS.
1 - Ø Ø
2 - 3 Ø ∠
3 - 1 Ø TEST
4 3 Ø Y

SECTIONS a,b,c,d,e,f,g,h,i

S5 SWITCH (MODE)

POS. 1 OFF, 2 ON — BALANCED 3Ø
3 NORMAL
4 I-II (NORMAL) — Ø-Ø FAULT
5 II-III — Ø-Ø FAULT
6 III-I — Ø-Ø FAULT

SECTIONS a,b,c,d,e,f,g,h,i,j

S6 SWITCH EXT. VOLTMETER

POS. 1 I-II
2 II-III
3 III-I
4 III-IV
5 II-IV
6 I-IV

NOTES

1 - ONE COLOR = SOLID COLOR.
W - WHITE WITH TRACER.
WB - WHITE/BLACK WITH TRACER.

2 - S4d / 3 TYPICAL SWITCH IDENTIFICATION.
S4 = SWITCH NUMBER.
d = SWITCH SECTION.
3 = POSITION IN WHICH CONTACTS ARE CLOSED.

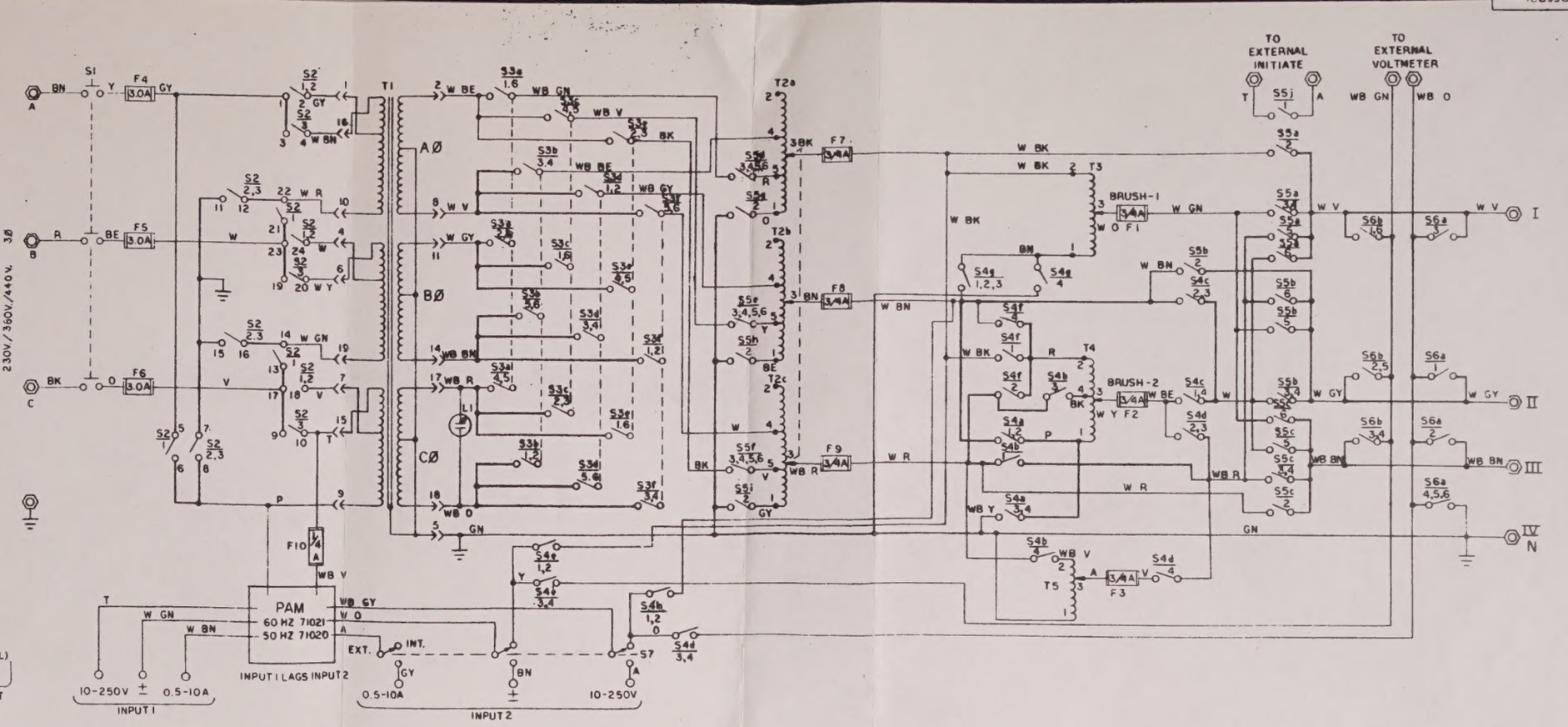
ITEM	PART NO.	DESCRIPTION	QTY
T3,5	3726	TRANSF., VAR.	2
PAM	71020A	DIGITAL PAM 50HZ (144878M)	1
F10	982	FUSE 1/2A	1
F4-6	951	FUSE 3A	3
F1-3,7-9	2679	FUSE 3/4 A 250V	6
	1403	SOCKET	1
	1404	PLUG	1
	949	FUSEHOLDER	1½
L1	3/6	LAMPHOLDER/1 AMP	1
PAM	71021A	DIGITAL PAM 60HZ (151458M)	1
S7	36	PAM EXT.-INT. SW.	1
6	709	EXT. VOLTMETER SW.	1
5	3371	MODE SW	1
4	3372	FUNCTION SW.	1
3	770	COARSE PHASE SW	1
2	3379	INPUT SELECTOR SW	1
S1	36	INPUT SW	1
T4	2683A	1Ø VAR. AUTO TRANSF	1
T2	2681	3Ø VAR. AUTO TRANSF	1
T1	6107	TRANSF. 6PH	1

multi-amp

TOLERANCES: DECIMAL ± .010, FRACTIONAL ± 1/64, UNLESS NOTED
UNITS: RMD
CHK'D
APP'D
DATE 10-19

TITLE: SCHEMATIC CG-7B
PART NO: 120V/208V/240V 14455 D-8

THE DEVICE DEPICTED AND DESCRIBED HEREON EMBODIES PROPRIETARY DESIGN OWNED BY MULTI AMP CORP. ALL DESIGN MANUFACTURING, REPRODUCTION SALES AND PATENT RIGHTS REGARDING THIS DEVICE OR DRAWING ARE RESERVED EXCEPT WHERE EXPLICIT RIGHT IS GRANTED IN WRITING.



S2 INPUT VOLTAGE

POS. VOLTAGE
1 — 230V.(LINE TO LINE)
2 — 380V.(LINE TO LINE)
3 — 440 V.(LINE TO LINE)

S3 SWITCH (COARSE)

POS. A-4
B-3
C-4
D-1
E-6
F-5

SECTIONS a,b,c,d,e,f

S4 SWITCH (FUNCTION)

POS.
1-Ø Ø
2-3 ØΔ
3-1 Ø TEST
4-3 Ø Y

SECTIONS a,b,c,d,e,f,g,h,i

S5 SWITCH (MODE)

POS. 1 OFF, 2 ON, 3 NORMAL — BALANCED 3Ø
4 I-II (NORMAL)
5 II-III
6 III-I — Ø-Ø FAULT

SECTIONS a,b,c,d,e,f,g,h,i,j

S6 SWITCH EXT. VOLTMETER

POS. 1 I-II
2 II-III
3 III-I
4 III-IV
5 II-IV
6 I-IV

SECTIONS a,b,c,d

NOTES

1-ONE COLOR = SOLID COLOR.
W - WHITE WITH TRACER
WB - WHITE/BLACK WITH TRACER.
2-S4d/3 TYPICAL SWITCH IDENTIFICATION
S4 = SWITCH NUMBER
d = SWITCH SECTION
3 = POSITION IN WHICH CONTACTS ARE CLOSED

L1	3	LAMP	1
T3,5	3726	VARIABLE TRANSF.	2
PAM	71020A	DIGITAL PAM 50 HZ	1
F10	7443	FUSE 1/4A 250V	1
F4,6	8900	FUSE 3.0A FNQ	2
F1-3,7-9	2679	FUSE 1/4A 250V	6
	1403	SOCKET	1
	1404	PLUG	1
	949	FUSEHOLDER 250V	7
	954	FUSEHOLDER 600V	6
L1	6	LAMPHOLDER	1
PAM	71021A	DIGITAL PAM 60 HZ	1
S7	36	PAM FAC.-INT. SW.	1
S6	7769	EXT. VOLTMETER SW.	1
S5	3371	MODE SW.	1
S4	3372	FUNCTION SW.	1
S3	770	COARSE PHASE SW.	1
S2	3378	INPUT SELECTOR SW.	1
S1	3378 Mod 7A, 4535, 4794	INPUT SW.	1
T4	2683A	1 Ø VAR. TRANSF.	1
T2	2681	3 Ø VAR. TRANSF.	1
T1	8679	TRANSFORMER	1
CT SYM	PART NO.	DESCRIPTION	

S/N 31307 & HIGHER

multi-amp

TOLERANCES: DECIMAL ± .010, FRACTIONAL ± 1/64, UNLESS NOTED

DRN. MAD | APP. | SCALE

CHK'D. W.B.F. | DATE 5/18/73 | SHT. 1

TITLE: SCHEMATIC CS-3

PART NO. 250V/360V/440V

18633D | 1

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